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Computer Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems (CAPDET) Program User's Guide

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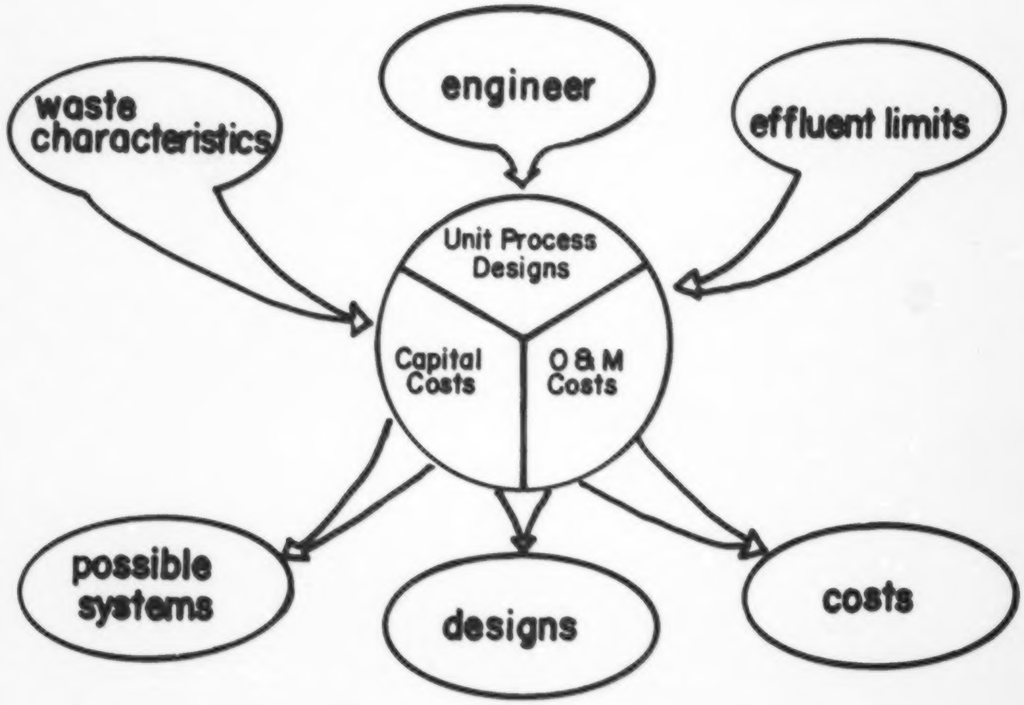
waste characteristics
engineer
effluent limits
Unit Process Designs
Capital Costs
O & M Costs
possible systems
designs
costs

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USER'S GUIDE

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This manual provides guidance for the selection of wastewater treatment processes and systems and criteria for the design of wastewater treatment facilities using the Computer Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems (CAPDET).

The information presented in this manual may be of interest to all persons concerned with the planning, design, and cost estimating associated with construction of new or upgraded wastewater treatment facilities.

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COMPUTER ASSISTED PROCEDURE FOR THE DESIGN AND EVALUATION OF WASTEWATER TREATMENT SYSTEMS (CAPDET) PROGRAM USER'S GUIDE

Environmental Engineering Division
Environmental Laboratory
U. S. Army Engineer Waterways Experiment Station
Vicksburg, Mississippi

January 1981

Prepared for: DEPARTMENT OF THE ARMY
Office of the Chief of Engineers
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and
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Office of Water Program Operations
Washington, D. C. 20460

NOTICE

The CAPDET program is dynamic in nature, undergoing continued updating and improvements based on the latest available design and cost information. From time-to-time, users will report errors or inconsistencies in the User's Guide or program. In addition, new information concerning specific processes may be received that necessitates appropriate changes to the User's Guide. As these changes are made, holders of record will be periodically notified.

The User's Guide transmitted herewith may be referred to as the January 1981 edition and is designed to accompany computer tapes dated 2 February 1981 modification.

For those holders of the original ("A" level) 2 February 1981 tape, several coding changes have been made to improve the CAPDET program. These will be made available on request. For information, contact:

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FOREWORD

The concurrent increase in demand for adequate wastewater treatment and advances in wastewater treatment technology has confronted the engineering profession with a situation in which there is a high level of demand for a service and limited manpower and monetary resources for meeting such demand. Available expertise must therefore be efficiently and effectively utilized. Stated simply, there exists the need for a screening tool capable of providing a methodology whereby a large number of alternative wastewater treatment systems, each capable of meeting specified effluent criteria, can be simultaneously ranked on the basis of cost effectiveness.

Computer assisted techniques are particularly suited to the task of insuring maximum efficient use of available resources. Over the past several years numerous computer based cost estimating models have been developed. All of these models have various limitations resulting in difficulties in application or computation. The Computer Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems (CAPDET) is designed to overcome, where possible, many of the difficulties associated with computerized cost estimating. This, by no means however, is meant to imply that CAPDET overcomes all limitations. The overall goal of CAPDET is to provide accurate planning level cost estimates. CAPDET does not replace the traditional engineering estimate or contractor's estimate based on a detailed set of plans and specifications.

This document provides detailed instructions for using and coding the CAPDET computer program.

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CHAPTER I

INTRODUCTION

1-1. Purpose. This manual provides guidance for the selection of wastewater treatment processes and systems and criteria for the design of wastewater treatment facilities using the Computer Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems (CAPDET).

1-2. Applicability. The information presented in this manual may be of interest to all persons concerned with the planning, design, and cost estimating associated with construction of new or upgraded wastewater treatment facilities. Reference should be made to the 10 July 1980 Construction Grants Program Operations Memorandum (POM) 80-3 which clarifies Environmental Protection Agency (EPA) policy on the use of CAPDET in Step 1 facilities planning. Basically, POM 80-3 encourages the use of CAPDET and provides for acceptance of CAPDET prepared cost estimates with little review.

1-3. References. See Appendix A for a list of selected references.

1-4. Scope.

a. The user's guide contains detailed instruction for coding data for the CAPDET model. This computer-based design procedure can be used to select viable process trains to meet a given effluent criteria and will rank the selected trains according to least annual cost. Cost and design data are included for large and small systems.

b. Available characterization data do not always include all of the input parameters required for certain processes. Therefore, typical default data have been included in the program to be used in the absence of user-specified values. The default data provided for each unit process are average values and may need adjustment to accurately reflect site-specific or waste-specific conditions.

c. The program contains a library of unit processes that may be used to treat a waste stream. Individual unit processes comprising a waste treatment scheme may be supplied with the appropriate design parameters pertinent to each process or the default values included in the program may be used. The program is sufficient in size and flexibility to allow for the processing of up to four general types of treatment schemes (e.g. physical-chemical, biological, land treatment, etc.).

d. When a treatment scheme is analyzed, the influent waste stream is processed in turn by each unit process on the liquid line. The treatment processes use the effluent of the previous process for their influent. Those processes producing sludge automatically output the sludge into one of two sludge lines (primary or secondary). These sludges may be processed separately or they may be mixed together. Figure 1-1 presents the organization chart for a treatment scheme.

e. The sequence of analysis for the processing of a waste stream involves analyzing all of the liquid line processes first, then processing the secondary sludge line, and finally processing the primary sludge line. Once the sequence is finished for a given process train, the effluent may be checked against preset effluent criteria. Those trains not meeting the desired effluent specifications are immediately discarded, while those meeting the desired effluent specifications are ranked in order by least present worth.

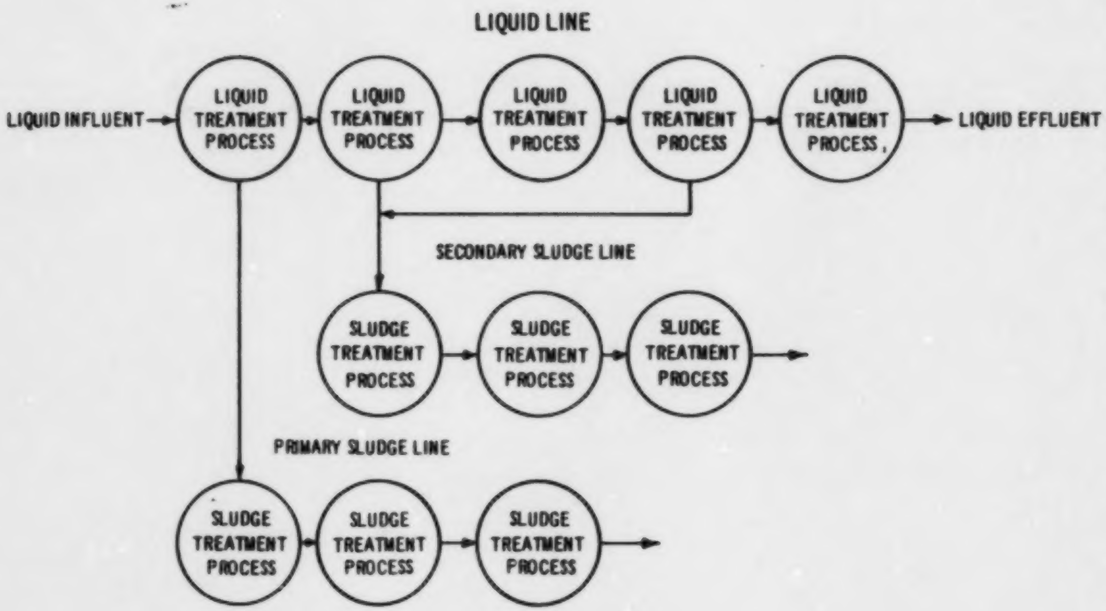
LIQUID LINE
LIQUID INFLUENT
LIQUID TREATMENT PROCESS
LIQUID TREATMENT PROCESS
LIQUID TREATMENT PROCESS
LIQUID TREATMENT PROCESS
LIQUID TREATMENT PROCESS
LIQUID EFFLUENT
SECONDARY SLUDGE LINE
SLUDGE TREATMENT PROCESS
SLUDGE TREATMENT PROCESS
SLUDGE TREATMENT PROCESS
PRIMARY SLUDGE LINE
SLUDGE TREATMENT PROCESS
SLUDGE TREATMENT PROCESS
SLUDGE TREATMENT PROCESS

Figure 1-1. Organization of a typical treatment scheme (prepared by WES)

CHAPTER 2

MODEL DESCRIPTION

2-1. Definitions.

a. Unit Process. A unit process is a single unique unit or group of parallel units of the same type. Examples of unit processes are bar screens, comminutors, grit chambers, contact stabilization processes, and secondary clarifiers.

b. Treatment Process. A treatment process is a sequence of one or more unit processes which are automatically linked together by CAPDET. For example, the preliminary treatment process consists of the unit processes bar screens, grit chambers, and comminutors linked in sequence. The contact stabilization treatment process consists of the contact stabilization unit process and a secondary clarifier. The filtration treatment process consists of merely the filtration unit process.

c. Block. A block is a treatment process location. The user of CAPDET may specify several alternative treatment processes for each treatment process location or block.

d. Scheme. A treatment scheme consists of the blocks on the liquid line, the secondary sludge line, and the primary sludge line.

e. Train. A train is similar to a scheme except that each block contains only one treatment process. A scheme may define several possible trains. CAPDET will automatically produce all trains specified in the treatment scheme by selecting all combinations of the alternatives in the blocks.

2-2. Program Organization.

a. This program allows the user to specify various types of unit processes for the treatment of wastewaters. A treatment process consists of one or more of these unit processes. The combination of unit processes into treatment processes is accomplished automatically by the CAPDET program. Treatment processes may then be assembled in sequence to form a treatment scheme. A scheme organization chart is shown in Figure 2-1, and a typical scheme is shown in Figure 2-2. A maximum of four treatment schemes may be specified. Each scheme contains a liquid line, a secondary sludge line, and a primary sludge line. A total of 60 blocks may be specified in each scheme. Each block may contain up to 10 alternative treatment processes.

b. A train consists of one treatment process from each block connected together in the sequence of the blocks. The program examines all combinations of treatment processes in the series of blocks and determines the cost for each train. The trains are saved in the computer and ranked according to least equivalent annual cost. If desired, the

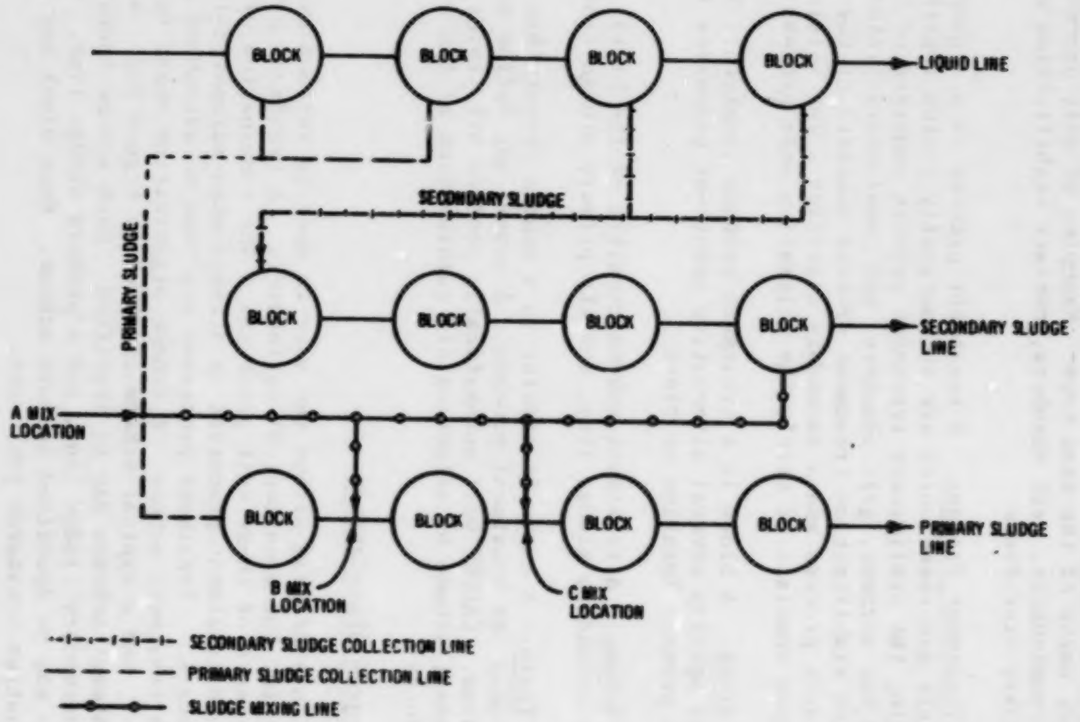
BLOCK
BLOCK
BLOCK
BLOCK
LIQUID LINE
SECONDARY SLUDGE
PRIMARY SLUDGE
BLOCK
BLOCK
BLOCK
BLOCK
SECONDARY SLUDGE LINE
A MIX LOCATION
BLOCK
BLOCK
BLOCK
BLOCK
PRIMARY SLUDGE LINE
B MIX LOCATION
C MIX LOCATION
SECONDARY SLUDGE COLLECTION LINE
PRIMARY SLUDGE COLLECTION LINE
SLUDGE MIXING LINE

Figure 2-1. Scheme organization chart (prepared by WES)

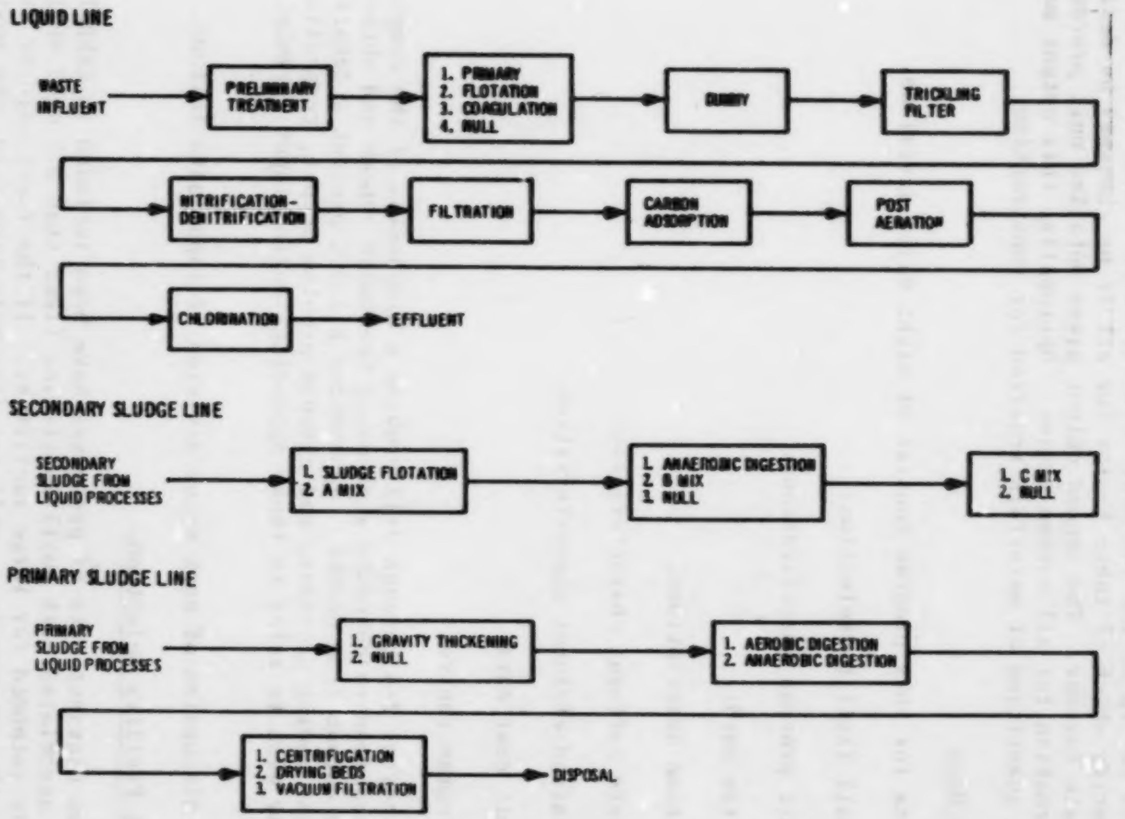
LIQUID LINE
WASTE INFLUENT
PRELIMINARY TREATMENT
1. PRIMARY
2. FLOTATION
3. COAGULATION
4. NULL
DUMMY
TRICKLING FILTER
NITRIFICATION-DENITRIFICATION
FILTRATION
CARBON ADSORPTION
POST AERATION
CHLORINATION
EFFLUENT
SECONDARY SLUDGE LINE
SECONDARY SLUDGE FROM LIQUID PROCESSES
1. SLUDGE FLOTATION
2. A MIX
1. ANAEROBIC DIGESTION
2. B MIX
3. NULL
1. C MIX
2. NULL
PRIMARY SLUDGE LINE
PRIMARY SLUDGE FROM LIQUID PROCESSES
1. GRAVITY THICKENING
2. NULL
1. AEROBIC DIGESTION
2. ANAEROBIC DIGESTION
1. CENTRIFUGATION
2. DRYING BEDS
3. VACUUM FILTRATION
DISPOSAL

Figure 2-2. A typical scheme. This represents one scheme and 192 trains (or variations) of that scheme. The program will evaluate all 192 trains but will save only the 100 most cost-effective (prepared by WES)

user may have the effluent checked against desired effluent characteristics. Those trains not meeting the desired effluent characteristics will be discarded. A maximum of 100 trains will be saved.

c. Two types of output may be obtained. The first output lists the cost data for up to the 100 most cost-effective trains. The user may also specify which of these trains (or all if he chooses) he desires to investigate further. The second output gives detailed unit process design information for all chosen trains. Optionally, this output may include the quantities of materials required for construction.

2-3. Input Data.

a. Data for this program consist of eight major divisions.

(1) Small facility selection.

(2) Unit process specifications.

(3) Title card.

(4) Scheme descriptions.

(5) Waste influent characteristics.

(6) Desired effluent characteristics.

(7) Unit cost data.

(8) Program control.

b. Sections 2-4 through 2-12 provide a discussion of the complete procedure required to describe a proposed treatment scheme and obtain the desired output from CAPDET. Appendices B and C present a detailed review of the coding procedure and example problem output, respectively. The user may wish to refer to these appendices during input formulation and coding.

c. A discussion of each major division of input data follows.

2-4. Small Facility Selection.

a. Two distinct sets of processes have been included in CAPDET. One set is associated with small facilities (less than 0.5 mgd) while the other is intended for large facilities. If the first card or line of input to the program is a small facility selection card, the small facility processes will be used. The data on this card begin in column one and should be coded as follows:

SMALL FACILITIES

If this card is omitted, the large facility processes will be used.

b. The two sets of processes cannot be intermixed. Once a selection is made by the inclusion or omission of the small facility selection card, the user is restricted to the use of processes included in the selected set.

2-5. Unit Process Specification.

a. The data cards used in the specification of a unit process consist of a key word in the first six columns of the card followed by the required numeric data in columns 7-80. The numeric data may be placed in any of the allowed columns but must be in the order shown for that particular card. No other numeric characters may be placed in columns 7-80. For purposes of this description, numeric characters are taken as the numerals 0-9, the minus sign (-), the plus sign (+), and the decimal point or period (.). Any other characters may be used in these columns to allow the user to identify the data items. Note, however, that the computer ignores these alphabetic descriptions and requires a specific order for the data on a card. The key word (columns 1-6) must appear exactly as shown on the card description.

b. The specification of a unit process begins with the process header card which names the process and terminates with an END card.

c. Data may be supplied for three separate modifications of each unit process. The three modifications are numbered zero, one, and two. If the modification number is omitted on the unit process header card, modification zero will be assumed. Default data have been included in the program for each of the three modifications for each unit process. These data may be changed by the user by specifying a unit process header card, data cards for the items the user wishes to change, and an END card. Default data or user-specified data must be available for each of the unit processes which will be used by the treatment processes specified on the BLOCK cards.

---

[a] The input may be in the form of cards or teletype lines. Since a line is equivalent to a card, the format described also applies to lines of input.

d. The following large facility unit processes may be specified:

Header Card Key Word	Large Facility Unit Processes
AIR FL	Flotation thickening
A SECO	Secondary clarification (activated sludge)
AERATE	Aerated lagoon
AEROBI	Aerobic digestion
ANAERO	Anaerobic digestion
ANION	Anion exchange
ATTACH	Attached growth denitrification
BELT F	Belt filter for sludge dewatering
CARBON	Carbon adsorption
CATION	Cation exchange
CENTRI	Centrifugation
CHLORI	Chlorination
CLARIF	Secondary clarification (user-specified)
COAGUL	Coagulation
COMMIN	Comminution
COMPLE	Complete mix activated sludge
CONTAC	Contact stabilization activated sludge
COSTS	User-specified costs for unit processes
COUNTE	Counter current ammonia stripping
CROSS	Cross current ammonia stripping
DENITR	Denitrification (suspended growth)
D SECO	Secondary clarification (suspended growth denitrification)

Header Card Key Word	Large Facility Unit Processes
DRYING	Drying beds
DUMMY	User-specified liquid process
EQUALI	Equalization
EXTEND	Extended aeration activated sludge
FILTRA	Filtration
FIRST	First stage recarbonation (lime treatment)
FLOCCU	Flocculation
FLOTAT	Flotation
FLTR P	Filter press
FLUIDI	Fluidized bed incineration
GRAVIT	Gravity thickening
GRIT R	Grit removal
HAULIN	Sludge hauling and land filling
HIGH R	High rate activated sludge
L PRIM	Primary clarification (two-step lime clarification)
LAGOON	Lagoons (stabilization ponds)
MICROS	Microscreening
MULTIP	Multiple hearth incineration
N SECO	Secondary clarification (suspended growth nitrification)
NEUTRA	Neutralization
NITRIF	Nitrification (suspended growth)
N RBC	Nitrification (rotating biological contractor)

Header Card Key Word	Large Facility Unit Processes
N TRIC	Nitrification (trickling filter)
O SECO	Secondary clarification (oxidation ditch)
OVERLA	Overland flow land treatment
OXIDAT	Oxidation ditch
PLUG F	Plug flow activated sludge
POST A	Postaeration
PRIMAR	Primary clarification
P SECO	Secondary clarification (pure oxygen)
PUMPIN	Intermediate pumping
PURE O	Pure oxygen activated sludge
RAPID	Rapid infiltration land treatment
RAW SE	Raw sewage pumping
RBC	Rotating biological contactor
RECARB	Recarbonation
R SECO	Secondary clarification (RBC)
SCREEN	Screening
SECOND	Second stage recarbonation (lime treatment)
SLOW I	Slow infiltration land treatment
SLUDGE	Sludge drying lagoons
STEP A	Step aeration activated sludge
T SECO	Secondary clarification (trickling filters)
TRICKL	Trickling filtration
USER S	User-specified sludge process

Header Card Key Word	Large Facility Unit Processes
VACUUM	Vacuum filtration
WET OX	Wet oxidation

e. The following small facility processes may be specified:

Header Card Key Word	Small Facility Unit Processes
ACTIVA	Activated sludge
AERATE	Aerated lagoon
BAR SC	Bar screens
CHLORI	Chlorination
COAGUL	Coagulation
COSTS	User-specified costs for unit processes
DRYING	Drying beds
DUMMY	User-specified liquid process
EQUALI	Equalization
FILTRA	Filtration
FLOTAT	Flotation
INTERM	Intermittent sand filtration
LAGOON	Lagoons
O SECO	Secondary clarification (oxidation ditch)
OVERLA	Overland flow land treatment
OXIDAT	Oxidation ditch
POST A	Postaeration
PRIMAR	Primary clarification
PUMPIN	Intermediate pumping

Header Card Key Word	Small Facility Unit Processes
RAPID	Rapid infiltration land treatment
RAW SE	Raw sewage pumping
T SECO	Secondary clarification (trickling filter)
SEPTIC	Septic tanks and tile fields
SLOW I	Slow infiltration land treatment
SLUDGE	Sludge drying lagoons
TRICKL	Trickling filtration
USER S	User-specified sludge process

f. The data cards for each of the large facility unit processes are described in Chapter 3. Small facility unit process data cards are described in Chapter 4. An xx.x shown on these cards indicates that a numeric value must be supplied. The last data card for each unit process is an END card.

2-6. Title Card.

a. A title card should be placed after the END card of the last unit process specification and prior to the LIQUID LINE card of the first scheme description. This title card allows an identification to be given at the top of each sheet of output. The card has the word TITLE in the first five columns followed by the desired description.

b. If the user wishes to completely rely on the default data, the data input should begin with a TITLE card or the TITLE card should immediately follow the small facility card (if used).

2-7. Scheme Description.

a. The fourth major division of input is the desired scheme descriptions. This input begins with the liquid line of the first scheme.

b. Each scheme description must begin with a LIQUID LINE card and may contain a SECONDARY SLUDGE LINE card and/or a PRIMARY SLUDGE LINE card. Inputs immediately following each of these line cards are BLOCK cards describing the treatment processes to be considered in that block. As many as ten alternative treatment processes may be specified in each block. A total of 60 blocks may be used in each treatment scheme.

c. To eliminate the need for the user to continually link together unit processes that are used in combination, treatment processes of one or more unit processes have been defined (e.g. secondary clarification following activated sludge).

d. Treatment processes consist of one or more unit processes (including the pseudo unit processes such as A MIX, B MIX, C MIX, and NULL). Only treatment process key words are used on the BLOCK cards.

e. Sludge treatment processes can only be used in conjunction with the secondary or primary sludge lines. Liquid processes can be used on the liquid line only. The NULL process can be used on any line. MIX processes can be used on the secondary sludge line only. Treatment processes are designated at a particular block by placing the six-character key word and one-character modification number describing that process in a position on the block card. The block card starts with the five-character key word BLOCK in columns 1-5, followed by the first treatment process key word and modification number in the seven-column position beginning in column 11. Subsequent treatment process key words and modification numbers are placed in succeeding seven-character fields.

f. Listed below are the various large facility treatment processes and the associated key words describing the unit processes which comprise the treatment process. The first 15 are sludge treatment processes, the last four are pseudo processes, and the others are liquid treatment processes.

	Treatment Process Key Words	Large Facility Treatment Process	Key Words for Associated Unit Processes
Sludge	AEROBI	Aerobic digestion	AEROBI
	AIR FL	Air flotation thickening	AIR FL
	ANAERO	Anaerobic digestion	ANAERO
	BELT F	Belt filter for sludge dewatering	BELT F
	CENTRI	Centrifugation	CENTRI
	DRYING	Drying beds	DRYING
	FLTR P	Filter press	FLTR P
	FLUIDI	Fluidized bed incineration	FLUIDI
	GRAVIT	Gravity thickening	GRAVIT
	HAULIN	Hauling and land filling	HAULIN

	Treatment Process Key Words	Large Facility Treatment Process	Key Words for Associated Unit Processes
Sludge	MULTIP	Multiple hearth incineration	MULTIP
	SLUDGE	Sludge drying lagoons	SLUDGE
	VACUUM	Vacuum filtration	VACUUM
	WET OX	Wet oxidation	WET OX
	USER S	User-specified sludge process	USER S
Liquid	AERATE	Aerated lagoon	AERATE
	ANION	Anion exchange	ANION
	ATTACH	Attached growth denitrification	ATTACH
	CARBON	Carbon adsorption	CARBON
	CATION	Cation exchange	CATION
	CHLORI	Chlorination	CHLORI
	CLARIF	Secondary clarification (user-specified)	CLARIF
	COAGUL	Coagulation	COAGUL
	COMPLE	Complete mix activated sludge	COMPLE, A SECO
	CONTAC	Contact stabilization activated sludge	CONTAC, A SECO
	COUNTE	Counter current ammonia stripping	COUNTE
	CROSS	Cross current ammonia stripping	CROSS
	DENITR	Denitrification (suspended growth)	DENITR, D SECO
	DUMMY	User-specified liquid process	DUMMY
	EQUALI	Equalization	EQUALI
	EXTEND	Extended aeration activated sludge	EXTEND, A SECO
	FILTRA	Filtration	FILTRA
	FLOTAT	Flotation	FLOTAT

	Treatment Process Key Words	Large Facility Treatment Process	Key Words for Associated Unit Processes
Liquid	HIGH R	High rate activated sludge	HIGH R, A SECO
	LAGOON	Lagoon	LAGOON
	MICROS	Microscreening	MICROS
	NEUTRA	Neutralization	NEUTRA
	NITRIF	Nitrification (suspended growth)	NITRIF, N SECO
	N RBC	Nitrification (rotating biological contactor)	N RBC
	N TRIC	Nitrification (trickling filter)	N TRIC
	OVERLA	Overland flow land treatment	OVERLA
	OXIDAT	Oxidation ditch	OXIDAT, O SECO
	PLUG F	Plug flow activated sludge	PLUG F, A SECO
	POST A	Postaeration	POST A
	PRELIM	Preliminary treatment	GRIT R, SCREEN, COMMIN
	PRIMAR	Primary clarifier	PRIMAR
	PUMPIN	Intermediate pumping	PUMPIN
	PURE O	Pure oxygen activated sludge	PURE O, P SECO
	RAPID	Rapid infiltration land treatment	RAPID
	RAW SE	Raw sewage pumping	RAW SE
	RBC	Rotating biological contactor	RBC, R SECO
	RECARB	Recarbonation	RECARB
	SLOW I	Slow infiltration land treatment	SLOW I
	STEP A	Step aeration activated sludge	STEP A, A SECO
	TRICKL	Trickling filtration	TRICKL, T SECO
	TWO ST	Two stage lime treatment	FLOCCU, L PRIM, FIRST, SECOND

	Treatment Process Key Words	Large Facility Treatment Process	Key Words for Associated Unit Processes
Pseudo	A MIX	Secondary and primary sludge mixing	NONE
	B MIX	Secondary and primary sludge mixing	NONE
	C MIX	Secondary and primary sludge mixing	NONE
	NULL	No process	NONE

g. The small facility treatment processes and the associated key words for their unit processes are listed below. There are three sludge processes, four pseudo processes, and 21 liquid processes.

	Treatment Process Key Words	Small Facility Treatment Process	Key Words for Associated Unit Processes
Sludge	DRYING	Drying beds	DRYING
	SLUDGE	Sludge drying lagoons	SLUDGE
	USER S	User-specified sludge process	USER S
Liquid	ACTIVA	Activated sludge (package plant)	ACTIVA
	AERATE	Aerated lagoon	AERATE
	PRELIM	Bar screens	SCREEN
	CHLORI	Chlorination	CHLORI
	COAGUL	Coagulation	COAGUL
	DUMMY	User-specified liquid process	DUMMY
	EQUALI	Equalization	EQUALI
	FILTRA	Filtration	FILTRA
	FLOTAT	Flotation	FLOTAT
	INTERM	Intermittent sand filtration	INTERM
	LAGOON	Lagoons	LAGOON
	OVERLA	Overland flow land treatment	OVERLA
	OXIDAT	Oxidation ditch	OXIDAT, O SECO

	Treatment Process Key Words	Small Facility Treatment Process	Key Words for Associated Unit Processes
Liquid	POST A	Postaeration	POST A
	PRIMAR	Primary clarification	PRIMAR
	PUMPIN	Pumping	PUMPIN
	RAPID	Rapid infiltration land treatment	RAPID
	RAW SE	Raw sewage pumping	RAW SE
	SEPTIC	Septic tanks	SEPTIC
	SLOW I	Slow infiltration land treatment	SLOW I
	TRICKL	Trickling filtration	TRICKL, T SECO
Pseudo	A MIX	Secondary and primary sludge mixing	NONE
	B MIX	Secondary and primary sludge mixing	NONE
	C MIX	Secondary and primary sludge mixing	NONE
	NULL	No process	NONE

h. A treatment process of a given modification number consists of one or more unit processes with the same modification number. For example, if the user wishes to specify modification one of the treatment process Extended Aeration, data must exist for the associated unit processes Extended Aeration (EXTEND) modification one and the Secondary Clarification (A SECO) modification one.

i. The mixing process, A MIX, B MIX, or C MIX, is used to mix the secondary sludge line into the primary sludge line before the first, second, or third block on the primary sludge line, respectively (Figure 2-1). The presence of a MIX block in a process train will cause processing of the secondary line to be terminated at that point. The NULL block is used to allow the option of a "no process" in a block of the train.

j. A typical treatment scheme was shown in Figure 2-2. The data cards describing that scheme are shown in Figure 2-3. Up to four treatment schemes may be described.

```
COLUMN 1         11    17 Mod No. 18    24 Mod No. 25    31 Mod No. 32
-------------------------------------------------------------------
       LIQUID LINE

       BLOCK     PRELIM

       BLOCK     PRIMAR FLOTAT COAGUL NULL

       BLOCK     TRICKL

       BLOCK     FILTRA

       BLOCK     CHLORI

       SECONDARY SLUDGE LINE

       BLOCK     SLUDGE A MIX

       BLOCK     ANAERO B MIX  NULL

       BLOCK     C MIX  NULL

       PRIMARY SLUDGE LINE

       BLOCK     GRAVIT NULL

       BLOCK     AEROBI ANAERO

       BLOCK     CENTRI DRYING VACUUM
-------------------------------------------------------------------
```

Figure 2-3. Scheme description format (prepared by WES)

2-8. Waste Influent Characteristics.

a. The fifth major division of input is the waste influent characteristics. The specification of waste influent characteristics begins with a header card containing the key word WASTE in the first five columns. The individual waste characteristics cards used in the specification of waste influent data consist of a key word in the first six columns of the card followed by the required numeric data in columns 7-80. The numeric data may be placed in any of the allowed columns but must be in the order shown for that particular card. No other numeric characters may be placed in columns 7-80. For purposes of this description, numeric characters are taken as the numerals 0-9, the minus sign (-), the plus sign (+), and the decimal point or period (.). Any other characters may be used in these columns to allow the user to identify the data items. Note, however, that the computer ignores these alphabetic descriptions and requires a specific order for the data on a card. The key word (columns 1-6) must appear exactly as shown on the card description.

b. The characteristic cards listed below may be used. The better the characterization of the waste, the better will be the results of the model. However, all 20 waste influent specification cards need not be included in order for the program to operate. NOTE: The waste characterization data must be given in the units indicated.

Key Word	Value	Units
WASTE INFLUENT CHARACTERISTICS		
MINIMUM FLOW	xx.x	MGD
AVERAGE FLOW Final = xx.x Initial =	xx.x	MGD
MAXIMUM FLOW	xx.x	MGD
TEMPERATURE Summer = xx.x Winter =	xx.x	DEG C
SUSPENDED SOLIDS	xx.x	MG/L
VOLATILE SOLIDS	xx.x	% OF SUSPENDED
SETTLEABLE SOLIDS	xx.x	ML/L
BOD5	xx.x	MG/L
SBOD (SOLUBLE)	xx.x	MG/L
COD	xx.x	MG/L
SCOD (SOLUBLE)	xx.x	MG/L
PH	xx.x	
CATIONS	xx.x	MG/L
ANIONS	xx.x	MG/L
PO4 (as P)	xx.x	MG/L
TKN (as N)	xx.x	MG/L
NH3 (as N)	xx.x	MG/L
NO2 (as N)	xx.x	MG/L
NO3 (as N)	xx.x	MG/L
OIL AND GREASE	xx.x	MG/L

c. The order of the waste characteristic cards is not important.

d. Default data describing a typical municipal waste have been included in the program. Waste influent characteristics not specified by the user will be taken from these default data. The user must specify the average flow, as no default value is supplied for this data item. If minimum or maximum flows are not specified, they will be set equal to the average flow automatically.

e. The input of waste characteristics is terminated with the header card for the desired effluent characteristics.

f. The default data included in the program are shown below:

```
TEMPERATURE           SUMMER 23  WINTER 10 DEG CENT
SUSPENDED SOLIDS           200 MG/L
VOLATILE SOLIDS             60 %
SETTLEABLE SOLIDS           15 MG/L
BOD5                       250 MG/L
SBOD SOLUBLE                75 MG/L
COD                        500 MG/L
SCOD SOLUBLE               400 MG/L
PH                         7.6
CATIONS                    160 MG/L
ANIONS                     160 MG/L
PO4                         18 MG/L
TKN                         45 MG/L
NH3                         25 MG/L
NO2                        0.0 MG/L
NO3                        0.0 MG/L
OIL AND GREASE              80 MG/L
```

2-9. Desired Effluent Characteristics.

a. The sixth major division of input data is the statement of the desired effluent characteristics. Only those characteristics the user wishes to have checked need be specified in the input. If the user does not wish to have any effluent characteristics checked, he need only list the header card.

b. The specification of the individual effluent characteristics is the same as for the waste influent and will not be repeated here. The header card must contain the key word DESIRE in the first six columns and may be specified as follows:

DESIRED EFFLUENT CHARACTERISTICS

c. The input of desired effluent characteristics is terminated with the unit cost header card UNIT COST. This header card must contain the key word UNIT C in the first six columns.

d. There are no default data for the desired effluent characteristics included in the program.

2-10. Unit Cost Data.

a. The seventh major division of input data is the unit cost data. This section of data input contains unit cost data input, cost indices input, and optional other direct construction cost data. The unit cost data cards that may be specified are listed below with their associated units.

Key Word	Value	Units
UNIT COST DATA		
BUILDING COST	xx.x	$/SQ FT
WALL CONCRETE	xx.x	$/CU YD
SLAB CONCRETE	xx.x	$/CU YD
EXCAVATION COST	xx.x	$/CU YD
MARSHALL AND SWIFT INDEX[a]	xx.x	
CRANE RENTAL	xx.x	$/HR
CANOPY ROOF COST	xx.x	$/SQ FT
LABOR RATE	xx.x	$/HR
OPERATOR II LABOR RATE	xx.x	$/HR
ELECTRICITY COST	xx.x	$/KWHR
CHEMICALS LIME = xx.x ALUM = xx.x IRON = xx.x POLYMER = xx.x[b]		$/LB
ENGINEERING NEWS RECORD INDEX	xx.x	
HANDRAIL COST	xx.x	$/FT
PIPE COST INDEX = xx.x INSTALLATION LABOR RATE = xx.x		S/HR
EIGHT INCH PIPE COSTS[c] PIPE = xx.x		$/FT
BEND = xx.x TEE = xx.x VALVE = xx.x		$/UNIT
LARGE CITY EPA INDEX[d]	xx.x	
SMALL CITY EPA INDEX[d]	xx.x	

---

[a] Available from Chemical Engineering magazine.

[b] Lime cost is cost per pound of $Ca(OH)_2$. Alum cost is cost per pound of 49% liquid alum. Iron cost is cost per pound of 40% liquid iron salt. Polymer cost is cost per pound of polymer. Chemical costs are not updated with cost indicies.

[c] PIPE = Cost of 8-in.-diam cast iron pipe; default value = $9.08/ft. BEND = Cost of 8-in.-diam cast iron bend; default value = $86.82. TEE = Cost of 8-in.-diam cast iron tee; default value = $128.49. Valve = Cost of 8-in.-diam cast iron plug valve; default value = $1346.16.

[d] Use large city or small city index, but not both; default value = large city.

Key Word	Value	Units
BLOWERS[e] COSTSBS = xx.x COSTSBM = xx.x COSTSBL = xx.x		$
REPLACEMENT LIFE FOR BLOWERS[f] RSBS = xx.x RSBM = xx.x RSBL = xx.x		YEARS
LAND COST	xx.x	$/ACRE
MISCELLANEOUS COST	xx.x	PERCENT
ADMINISTRATIVE/LEGAL COST	xx.x	PERCENT
201 PLANNING COST	xx.x	PERCENT
INSPECTION COST	xx.x	PERCENT
CONTINGENCY COST	xx.x	PERCENT
PROFIT AND OVERHEAD COST	xx.x	PERCENT
TECHNICAL COST	xx.x	PERCENT
SPECIAL FOUNDATIONS[g]	xx.x	$
PUMPING FOR EFFLUENT[g]	xx.x	$
DIFFUSER FOR OUTFALL[g]	xx.x	$
MOBILIZATION[g]	xx.x	$
CLEARING AND GRUBBING AND SITE PREP[g]	xx.x	$
SITE ELECTRICAL[g]	xx.x	$
YARD PIPING[g]	xx.x	$
LAB AND MAINT AND ADMIN BUILDING[g]	xx.x	$
RAW WASTE PUMPING[g]	xx.x	$
INSTRUMENTATION AND CONTROL[g]	xx.x	$
EFFLUENT PIPING[g] (NONOCEAN)	xx.x	$
OCEAN OUTFALL[f]		
END		

---

[e] COSTSBS = Cost of standard 3,000 scfm at 8 psig capacity rotary positive displacement blower; default value = $16,000. COSTSBM = Cost of standard 12,000 scfm at 8 psig capacity vertically split multistage centrifugal blower; default value = $45,000. COSTSBL = Cost of standard 50,000 scfm at 8 psig capacity pedestal-type single-stage centrifugal blower; default value = $300,000. Plant air requirements are accumulated and one blower system is designed for entire plant.

[f] See Appendix F.

[g] Optional cards which must be used when the indicated facilities are required. Where the optional card is included with an omitted dollar ($) value, costs will be computed using FRD-11 cost equations. These costs may range from 35 to 50 percent of treatment plant construction.

b. The unit cost data section begins with the UNIT COST DATA header card and is terminated with an END card. The data cards used in the specification of unit costs data consist of a key word in the first six columns of the card followed by the required numeric data in columns 7-80. The numeric data may be placed in any of the allowed columns but must be in the order shown for that particular card. No other numeric characters may be placed in columns 7-80. For purposes of this description, numeric characters are taken as the numerals 0-9, the minus sign (-), the plus sign (+), and the decimal point or period (.). Any other characters may be used in these columns to allow the user to identify the data items. Note, however, that the computer ignores these alphabetic descriptions and requires a specific order for the data on a card. The key word (columns 1-6) must appear exactly as shown on the card description. Note that if one number on a card is changed, all values must be input even if the remaining desired values are equivalent to default values.

c. The CAPDET model uses a unit process battery limits of construction concept enabling the user to construct alternative treatment trains. Consideration of those costs associated with total plant construction requires the user to review the optimal cost cards and include those that are applicable in the input data set. Failure to include these costs can result in a severe underestimate of plant construction costs. For conventional mechanical type treatment schemes, all of the optimal cost cards should be considered. Due to the nature of land treatment systems, yard piping as well as clearing, grubbing, and site preparation should not be specified. In addition, the costs for site electrical and instrumentation and control should be reduced to reflect the simplicity of these cost elements for lagoon systems and land treatment systems.

d. Default data for the unit cost items included in the program are listed below:

```
BUILDING COSTS                                48.00             $/SQ FT
EXCAVATION                                     1.20             $/CU YD
WALL CONCRETE                                207.00             $/CU YD
SLAB CONCRETE                                 91.00             $/CU YD
MARSHALL AND SWIFT INDEX                     577.00
CRANE RENTAL                                  67.00             $/HR
CANOPY ROOF                                   15.75             $/SQFT
LABOR RATE                                    13.40             $/HR
OPERATOR II LABOR RATE                         7.50             $/HR
ELECTRICITY                                    0.04             $/KHR
CHEMICAL COST LIME 0.03  ALUM 0.04  IRON 0.06   POLYMER 1.62 $/LB
ENGINEERING NEWS RECORD COST INDEX          2886.00
HAND RAIL                                     25.20             $/FT
PIPE COST INDEX 295.2  PIPE INSTALLATION LABOR RATE 14.70  $/HR
LARGE CITY EPA INDEX                         163.00
MISCELLANEOUS NONCONSTRUCTION COSTS            5.00             PERCENT
ADMIN/LEGAL                                    2.00             PERCENT
201 PLANNING                                   3.50             PERCENT
INSPECTION                                     2.00             PERCENT
CONTINGENCIES                                  8.00             PERCENT
PROFIT AND OVERHEAD                           22.00             PERCENT
TECHNICAL COSTS                                2.00             PERCENT
LAND COSTS                                  1000.00             $/ACRE
```

2-11. Program Control Cards.

a. The eighth and final major division of input is made up of the control cards. This input section begins with the header card CONTROL CARDS and will be terminated with the control card GO.

b. Program control cards use the same format as the unit process specification cards, i.e. the first four characters must be in columns 1-4, and any numerical data may appear anywhere in columns 7-80. The following control cards may be used:

CONTROL CARDS (header card)

ANALYZE

LIST TOTAL OF xxx TRAINS

PRESENT WORTH OF TRAINS x x-x x

CONSTRUCTION COSTS OF TRAINS x x-x x

PROJECT COSTS OF TRAINS x x-x x

ENERGY COSTS OF TRAINS x x-x x

OPERATION AND MAINTENANCE COSTS OF TRAINS x x-x x

OUTPUT QUANTITIES

SUMMARY ONLY

GO I = xx.x % NY = xx.x Years NYC = xx.x

c. The GO card should be the last card included in the data. The GO card is required as it causes the program to begin its execution phase. The letters GO must appear in columns 1 and 2 with all other data beginning no sooner than column 7. The sequence of the three numeric values (interest rate, project design life, and construction period) must be specified in the order as shown. The interest rate, project design life, and construction period must be specified as no default data are provided for these three values. All other output control cards are optional.

d. The ANALYZE card causes unit process design data to be printed on the first pass through the program in the order in which each train is initially processed, i.e., prior to economic ranking or checking for effluent quality. The OUTPUT QUANTITIES card may be used with the ANALYZE card to cause the quantities computed for estimate costing to be printed for each unit process. After the unit process design data have been output for each treatment process of the train, the waste effluent constituents are output so that the user may review the expected treatment efficiency of the treatment process. The SUMMARY ONLY card may be used with the ANALYZE card to suppress the printing of the unit process design data and only output the waste influent and effluent and the cost summary page of the train.

e. The LIST T card will cause a schematic of the specified number of trains to be output. The schematic will consist of each treatment process and its modification number on the liquid line, the secondary sludge line, and the primary sludge line. In addition, the present worth costs, total project costs, total construction costs, total operation and maintenance costs, and total energy costs are ranked in ascending order with the associated train number for the specified number of trains.

f. The PRESENT worth card may be used to output the unit process design data and the expected effluent of each treatment process in the specified trains. The trains to be output may be specified individually or may be specified over a range, or both. For example, the control card

```
PRESENT WORTH   1   3   5-8   10
```

would cause unit process design data and effluent data to be output for the treatment processes for the trains which ranked first, third, fifth, sixth, seventh, eighth, and tenth by present worth cost. The same result could be accomplished by the control card

```
PRESENT WORTH   1   3   5   6   7   8   10
```

When a range of trains are specified, the user must specify both limits of the range with a dash (minus sign) between the limits. No blank spaces should appear between the beginning limit and the dash or the dash and the ending limit. Either the OUTPUT QUANTITITES card or the SUMMARY ONLY card may be used with the PRESENT WORTH card.

g. The CONSTRUCTION card may be used to output the unit process design data and effluent data for the treatment processes in the specified trains as ranked by total construction costs (exclusive of project indirect costs). The train specifications are made exactly like the train specifications on the PRESENT WORTH card. The OUTPUT QUANTITIES or SUMMARY ONLY cards may be used with the CONSTRUCTION card.

h. The PROJECT card may be used to output the unit process design data and effluent data for the treatment processes in the specified trains as ranked by total project cost. The train specifications are made exactly like the train specifications on the PRESENT WORTH card. The OUTPUT QUANTITIES or SUMMARY ONLY cards may be used with the PROJECT card.

i. The ENERGY card may be used to output the unit process design data and the effluent data for the treatment processes in the specified train as ranked by the total energy costs. The train specifications are made exactly like the train specifications on the PRESENT WORTH card. The OUTPUT QUANTITIES or SUMMARY ONLY cards may be used with the ENERGY card.

j. The OPERATION card may be used to output the unit process design data and effluent data for the treatment processes in the specified trains as ranked by total annual operation and maintenance costs. The train specifications are made exactly like the train specifications on the PRESENT WORTH card. The OUTPUT QUANTITIES or SUMMARY ONLY cards may be used with the OPERATION card.

k. Figure 2-4 shows the total input required to make the program run. The user should refer to the detailed procedure for data ouput in Appendix B.

2-12. Cost Analysis in the Computerized Design Process.

a. The user, through the use of the GO control card, inputs the interest rate and design life into the program. These parameters are described in 2-11c.

b. The annual interest rate is used to amortize the capital cost and compute the equivalent annual cost to determine the most cost-effective process train. The design life pertains to the period over which the design is evaluated for cost-effectiveness.

c. Cost data for the unit processes used in the process train are stored in the program. These cost data form the basis for an analysis of the capital, O&M, present worth, and equivalent annual costs of the process trains.

d. To allow for unique site-specific problems, the user may elect to input locally generated costs for some or all unit processes. These cost data will then override the cost equations or cost estimate formulations used in the model. The format for the user-specified costs for each process is shown in Chapter 3 and Chapter 4.

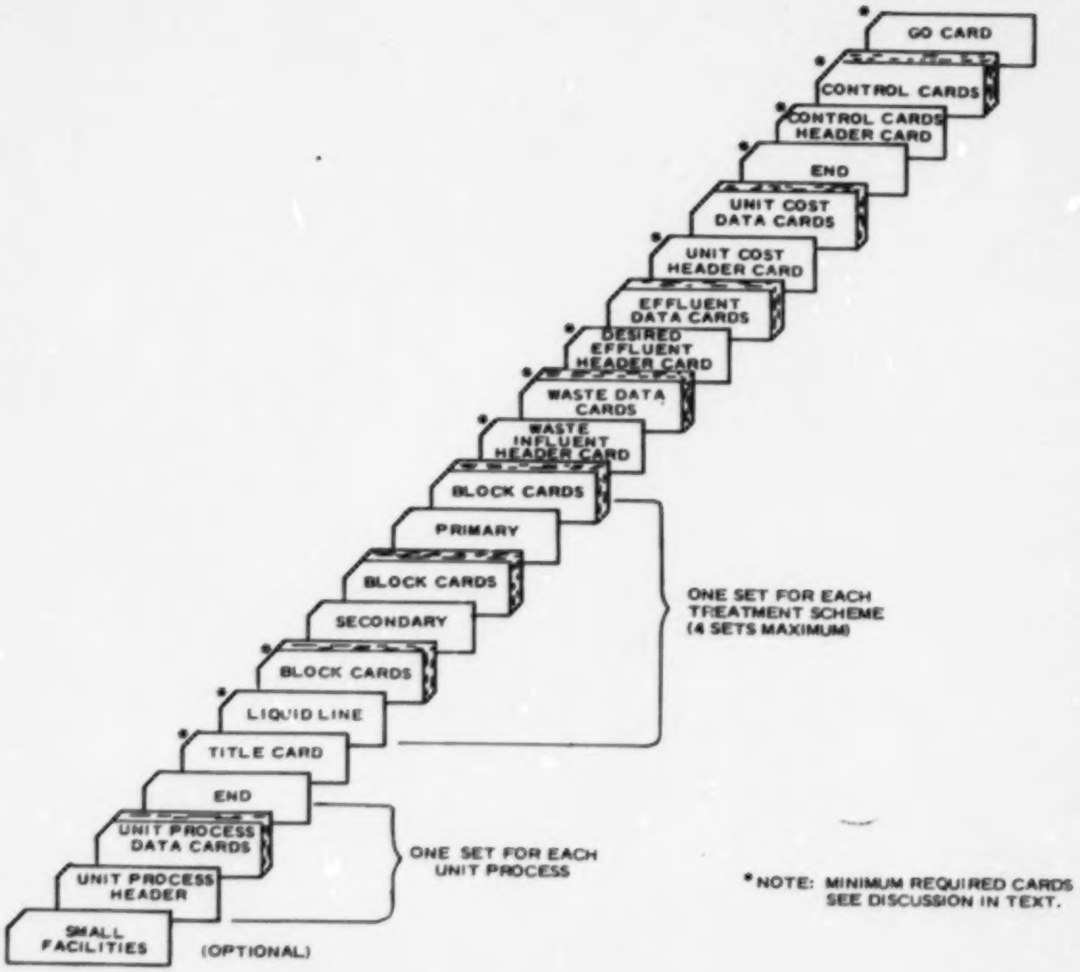
GO CARD
CONTROL CARDS
CONTROL CARDS HEADER CARD
END
UNIT COST DATA CARDS
UNIT COST HEADER CARD
EFFLUENT DATA CARDS
DESIRED EFFLUENT HEADER CARD
WASTE DATA CARDS
WASTE INFLUENT HEADER CARD
BLOCK CARDS
PRIMARY
BLOCK CARDS
SECONDARY
BLOCK CARDS
LIQUID LINE
TITLE CARD
END
UNIT PROCESS DATA CARDS
UNIT PROCESS HEADER
SMALL FACILITIES
(OPTIONAL)
ONE SET FOR EACH TREATMENT SCHEME (4 SETS MAXIMUM)
ONE SET FOR EACH UNIT PROCESS
*NOTE: MINIMUM REQUIRED CARDS SEE DISCUSSION IN TEXT.

Figure 2-4. Input data cards (prepared by WES)

CHAPTER 3

LARGE FACILITY UNIT PROCESS SPECIFICATIONS

3-1. Introduction.

a. General. This chapter contains the specific input data for each large facility unit process. Unit process specifications included in this chapter should be used only if the SMALL FACILITY card was omitted. Each line of data that may be included for a particular unit process is listed along with the proper units. Each line of data under each unit process in this chapter corresponds to one card or line of input to the model. It is permissible to interchange whole lines of data; however, within each line the data must be typed in the order shown. The unit process name (header card) and the END card must be the first and last lines or cards, respectively, for each unit process.

b. Estimate Costing. This is a new approach to planning level costing. For each process, a typical configuration and method of construction has been assumed. Using these assumptions, quantities are calculated and costs extended by multiplying by unit costs supplied by the user. This allows the user to update the cost base to his specific location and to the current year by inputting the current unit prices.

c. ESTIMATE Card. The ESTIMATE card which may optionally be included in the unit process input data specifies that estimate type costing is to be used for the particular process. In general, the data on this card will include the cost of one or more standard size items of equipment. Costs of the required sizes of these items of equipment will be generated within the program. If the user elects to specify the costs of these items, he should use the current cost of the standard size unit. If these costs are omitted from the ESTIMATE card or are specified as zero, the program will use the first quarter 1977 cost updated by the Marshall and Swift equipment cost index specified in the unit cost input.

d. Parametric Costing. For the unit processes in which estimate costing has not been implemented, costs will be computed using parametric equations obtained from various sources. Where applicable, the Dames and Moore equations will be used. These costs will be updated to the current year using the EPA construction cost index. Where parametric cost equations are not available, some costs will be indicated as zero. For this reason, extreme care should be used in evaluating costs generated using the parametric equations. Processes which use parametric costing may be identified by the absence of an ESTIMATE card in the unit process specification input data.

e. Default Data. Default data have been included within the program for the three modifications of all unit processes included within CAPDET. Thus, for any modification of these processes, it is necessary to include data only for those data items the user wishes to change. However, any data change within a line of input requires input of all

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data items on that particular line. To change one or more data items the user should specify a unit process header card for the modification number of the process followed by data cards for those items the user wishes to change. An END card will conclude input of data for that process.

f. REPLACEMENT Card. Detailed cost analysis requires consideration of equipment and structural component service lives. The REPLACEMENT card, which may be used as an optional unit process data input, allows the user to specify service lives of various components. Since in general the user will prefer to use default data and for the sake of convenience in manual formatting, a detailed explanation of the REPLACEMENT card variables is included in Appendix F rather than on the unit process specification page.

3-2. Aerated Lagoon.

a. Design parameters for Eckenfelder's approach are listed below:

Parameter	Suggested Values
K	Reaction rate constant; aerobic = 0.007-0.002 ℓ/mg/hr; faculative = 0.50-1.00 per day
A	Fraction of BOD synthesized = 0.73
AP	Fraction of BOD oxidized for energy = 0.52
B	Endogenous respiration rate (sludge basis) = 0.075/day
BP	Endogenous respiration rate (oxygen basis) = 0.15/day
P	Pressure correction factor = 1.0
ALPHA	O_2 transfer in waste/O_2 transfer in water = 0.90
BETA	O_2 saturation in waste/O_2 saturation in water = 0.90
THETA	Temperature coefficient; aerobic = 1.035; facultative - 1.075
HPR	Minimum horsepower required for mixing ≥ 0.06 hp/1000 gal
STE	Standard transfer efficiency Mechanical aerators = 2.0-3.5 lb O_2/hp-hr High speed = 2.0 Slow speed = 3.5

Additional parameters include:

Detention time = 2-4 days
Mixed liquor suspended soilds (facultative) = 70-200 mg/ℓ
Mixed liquor volatile suspended solids (facultative) = 50-150 mg/ℓ

b. Default data are listed below:

```
SUMMER TEMPERATURE                    23.0 DEG C
WINTER TEMPERATURE                    10.0 DEG C
EFFLUENT BOD SOLUBLE                  10.0 MG/L
MINIMUM DISSOLVED OXYGEN               3.0 MG/L
CONSTANTS K=0.00135 A=0.73 AP=0.52 B=0.075 BP=0.15 THETA=1.035 P=1.0
MECHANICAL AERATION  ALPHA=0.9  BETA=0.9  HPR=0.06  STE=2.0
DETENTION TIME                         4.0 DAYS
LINER COST                            0.30 $/SQ FT
MIXED LIQUOR        SS=400.0 MG/L   VSS=320.0 MG/L
COMPLETE MIX AERATED LAGOON
```

c. Aerated lagoon unit process data cards are listed below:

AERATED LAGOON MOD xx

SUMMER TEMPERATURE xx.x DEG C

WINTER TEMPERATURE xx.x DEG C

EFFLUENT SOLUBLE BOD xx.x MG/L

CONSTANTS K = xx.x A = xx.x AP = xx.x B = xx.x
BP = xx.x THETA = xx.x P = xx.x

MECHANICAL AERATION ALPHA = xx.x BETA = xx.x
HPR = xx.x HPR/TGAL STE = xx.x LB O_2/HPR-HR

DETENTION TIME (HYDRAULIC)[a] xx.x DAYS

MINIMUM DISSOLVED OXYGEN xx.x MG/L

LINER REQUIRED[b] UPILL = xx.x $/SQ FT RSLL = xx.x YEARS

COMPLETE MIX AERATED[c]

FACULTATIVE AERATED LAGOON[c]

MIXED LIQUOR[d] SS = xx.x VS = xx.x MG/L

ESTIMATE[e] COSTSA = xx.x $

REPLACEMENT[f] RSSA = xx.x RSST = xx.x YEARS

END

---

[a] Hydraulic detention time is a minimum detention time. Detention time will be calculated based on summer and winter temperatures. The larger of the hydraulic detention time and the two calculated detention times will be used.

[b] Liner is optional; UPILL = Cost of liner installed; default valve = $0.30/sq ft; RSLL = Replacement schedule for liner; default value = 15 years.

[c] Use complete mix or facultative, not both; default value = complete mix.

[d] Use only with facultative lagoons; will be calculated in complete mix lagoons.

[e] COSTSA = Cost of standard 50-hp high-speed floating aerator; default value = $13,960.

[f] See Appendix F.

3-3. Aerobic Digestion.

a. Design parameters for aerobic digestion are listed below:

Detention time, days at 20°C
  Activated sludge only = 12-16 days
  Activated sludge from plant without primary settling = 16-18 days
  Primary sludge plus activated or trickling filter sludge = 18-22 days
Detention time should be increased for temperatures below 20°C

Volatile solids destroyed: 40 percent is common but it increases with temperature and retention time from approximately 33 to 70%

Mixed liquor solids = 12,000 mg/ℓ

Solids in digested sludge = 2.5%

Additional parameters include:

Parameter	Suggested Values
Alpha	O_2 transfer in waste/O_2 transfer in water = 0.9
Beta	O_2 saturation in waste/O_2 saturation in water = 0.9
STE	Standard transfer efficiency Diffused aerator = 6.0-11.0% Coarse bubble = 6.0 Fine bubble = 11.0 Mechanical aerator = 2.0-3.5 lb O_2/hp-hr High speed = 2.0 Slow speed = 3.5

b. Default data are listed below:

```
DETENTION TIME                           15        DAYS
VOLATILE SOLIDS DESTROYED                40        PERCENT
MIXED LIQUOR SOLIDS                      12000     MG/L
SOLIDS IN DIGESTED SLUDGE                2.5       PERCENT
DIFFUSED AERATION     ALPHA=0.9  BETA=0.9   STE=6 PERCENT
TEMPERATURE                              20        CENT
```

c. **Aerobic digestion unit process data cards are given below:**

AEROBIC DIGESTION	**MOD xx**	
DETENTION TIME	**xx.x**	**DAYS**
VOLATILE SOLIDS DESTROYED	**xx.x**	**PERCENT**
MIXED LIQUOR SOLIDS	**xx.x**	**MG/L**
SOLIDS IN DIGESTED SLUDGE	**xx.x**	**PERCENT**
DIFFUSED AERATION[a] **ALPHA = xx.x BETA = xx.x** **STE = xx.x**		**PERCENT**
MECHANICAL AERATION[a] **ALPHA = xx.x BETA = xx.x** **STE = xx.x**		**LB O/HPR-HR**
TEMPERATURE	**xx.x**	**DEG CENT**
ESTIMATE[b] **SSXSA = xx.x COSTPD = xx.x COSTPH = xx.x**		**$**
REPLACEMENT[c] **RSSA = xx.x RSPD = xx.x** **RSPH = xx.x RSST = xx.x**		**YEARS**
END		

---

[a] Use mechanical or diffused, not both; default value = diffused.

[b] SSXSA = Cost of standard slow-speed, pier-mounted 20-hp aerator; default value = $16,300. COSTPD = Cost of standard 12.0-scfm coarse-bubble diffuser; default value = $6.50. COSTPH = Cost of standard 550-scfm swing arm diffuser; default value = $5,000.

[c] See Appendix F.

3-4. Anaerobic Digestion.

a. Design parameters are given below:

Specific gravity = 1.05
Percent volatile solids destroyed (see Figure 3-1 provided below) = 40-60%
Concentration of solids in digester = 3-7%

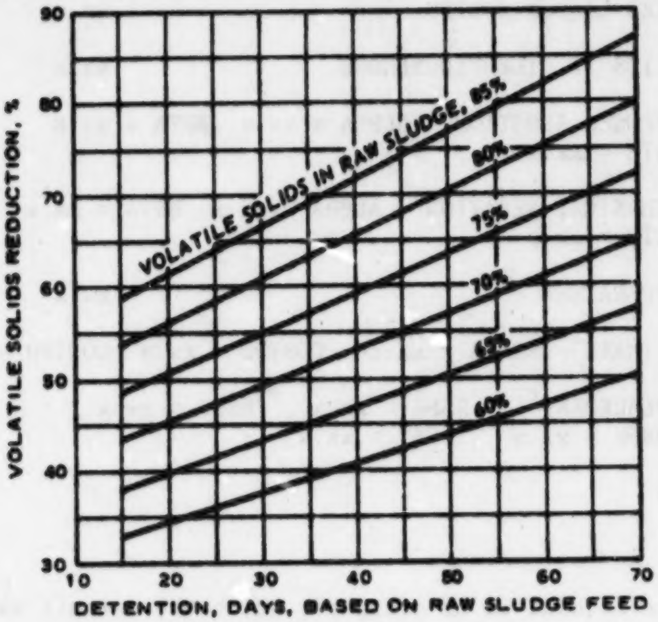

Figure 3-1. Reduction in volatile solids in raw sludge, for detentions from 15 to 70 days, Temperature T = 85° to 95°F (courtesy of American Society of Civil Engineers and the Water Pollution Control Federation 1977)

b. Default data are given below:

```
SOUTHERN U S
SPECIFIC GRAVITY                        1.05
PERCENT VS DESTROYED                    50          PERCENT
CONCENTRATION IN DIGESTER               5           PERCENT
TEMPERATURE     RAW=70    DIGESTER=100  AIR=40      DEG F
```

c. Anaerobic digestion unit process data cards are listed below:

ANAEROBIC DIGESTION MOD xx

SPECIFIC GRAVITY xx.x

PERCENT VS DESTROYED xx.x PERCENT

CONCENTRATION IN DIGESTER xx.x PERCENT

TEMPERATURE RAW = xx.x DIGESTER = xx.x
AIR = xx.x DEG F

SOUTHERN UNITED STATES[a]

MIDDLE UNITED STATES[a]

NORTHERN UNITED STATES[a]

ESTIMATE[b] SFLOCO = xx.x CGCUS = xx.x HRHXS = xx.x
CGSES = xx.x CSPUMP = xx.x COSNG = xx.x

REPLACEMENT[c] RSCO = xx.x RSUS = xx.x RSXS = xx.x
RSES = xx.x RSMP = xx.x RSST = xx.x YEARS

END

---

[a] Use only one of Southern, Middle, or Northern cards; default value = Southern United States.

[b] SFLOCO = Cost of standard 70-ft-diam floating cover; default value = $71,000. CGCUS = Cost of standard 60-ft-diam gas circulation unit; default value = $32,000. HRHXS = Cost of standard 1 million Btu/hr heating unit; default value = $49,000. CGSES = Cost of standard 2-in.-diam gas safety equipment; default value = $7,100. CSPUMP = Cost of standard size sludge pump (8 gpm at 70 ft of head); default value = $2,500. COSNG = Cost of natural gas; default value = $2.30/1,000 cu ft.

[c] See Appendix F.

3-5. Anion Exchange.

a. Design parameters for anion exchange are listed below:

Treatment flow rate = 2-5 gpm/cu ft

Regenerant flow rate = 1-2 gpm/cu ft

Rinsing flow rate = 0.5-1.5 gpm/cu ft

Amount of rinse water = 30-120 gal/cu ft

Column depth = 24-30 in. minimum

Amount of backwash water = 30-100 gal/cu ft

Backwash water rate = 4.0-12.0 gpm/cu ft

Resin exchange capacity = lb/cu ft (consult manufacturer specifications)

Regenerant dose, level, concentration, and specific gravity (consult resin manufacturer specifications)

b. Default data are given below:

```
EFFLUENT CONCENTRATION              2          MG/L
RESIN EXCHANGE CAPACITY             4          LB/CFT
REGENERATE   DOSE=12 LB/CFT  LEVEL=7.5 LB/CFT  CONC=7.5 PER  SG=1.04
FLOW RATES  TREAT=3  REGENT=1.5  RINSE=1.0  GPM/CFT
HOURS PER DAY                       8          HOURS
AMOUNT OF RINSE WATER               60         G/CFT
COLUMN DEPTH                        24         INCHES
BACKWASH   AMOUNT= 100  G/CFT   RATE= 10 GPM/CFT
```

c. Anion exchange unit process data cards are listed below:

```
ANION EXCHANGE[a]               MOD xx

EFFLUENT CONCENTRATION                          xx.x     MG/L

RESIN EXCHANGE CAPACITY                         xx.x     LB/CU FT

REGENERANT DOSE = xx.x  LB/CU FT  LEVEL = xx.x           LB/CU FT
  CONC = xx.x PERCENT  SPECIFIC GRAVITY = xx.x

FLOW RATES TREAT = xx.x  REGEN = xx.x  RINSE = xx.x      GPM/CU FT

HOURS PER DAY                                   xx.x     HOURS

AMOUNT OF RINSE WATER                           xx.x     G/CU FT

COLUMN DEPTH                                    xx.x     INCHES

BACKWASH AMOUNT = xx.x G/CU FT  RATE = xx.x   GPM/CU FT

REPLACEMENT[b]    RSST = xx.x                            YEARS

END
```

---

[a] This unit process is parametrically costed.

[b] See Appendix F.

3-6. Belt Filtration for Sludge Dewatering.

a. Design parameters for pressure filtration are listed below:

Density of cake = 70.0-80.0 lb/cu ft

Solids loading rate (determine from lab tests)
= 5.0-8.0 lb/sq ft/hr

Operating schedule = 8.0-16.0 hr/day

Cake solids content (see Table 3-1)

Table 3-1. Belt Filtration Unit Performance[a]

Unit	Sludge Type	Influent Sludge Solids %	Sludge Cake Solids %
Moving screen concentrator	Activated	0.5-1.0	8-10
	Primary		20-30
Belt pressure filters	Primary	5.7	19
Capillary dewatering systems	Activated	1.0-1.5	15-18
Dual cell gravity with multiroll press	Raw primary	3	20-23
	Digested	0.5-4.0	16-20
	WAS[b]	1.9-3.0	18-23

[a] Prepared by WES.

[b] WAS = waste activated sludge.

b. Default data are given below:

```
CAKE SOLIDS CONTENT                     19.0   PERCENT
DENSITY OF CAKE                         75.0   LB/CUFT
OPERATING SCHEDULE                       8.0   HOURS/DAY
SOLIDS LOADING RATE                      6.0   LB/SQFT/HR
CONDITIONING MATERIAL                    5.0   PERCENT
```

c. Belt filtration unit process data cards are listed below:

BELT FILTRATION[a]	MOD xx	
CAKE SOLIDS CONTENT	xx.x	PERCENT
DENSITY OF CAKE	xx.x	LB/CU FT
OPERATING SCHEDULE	xx.x	HOURS/DAY
SOLIDS LOADING RATE	xx.x	LB/SQ FT/HR
CONDITIONING MATERIAL	xx.x	PERCENT
REPLACEMENT[b]	RSST = xx.x	
END		

---

[a] This unit process is parametrically costed.

[b] See Appendix F.

3-7. Carbon Adsorption.

a. Design parameters for carbon adsorption are given below:

Virgin carbon density = 26 lb/cu ft

Spent carbon density = 32 lb/cu ft

Superficial velocity = 4-8 gpm/sq ft

Height of underdrain above adsorber bottom = 2.0 ft

Empty bed residence time (contact time) = 15-35 min

Adsorber capacity = 0.3-0.8 lb chemical oxygen demand (COD)/lb carbon

Backwash rate = 10-15 gpm/sq ft

Backwash duration = 15 min

Furnace loading rate = 70-80 lb/sq ft/day

b. Default data are given below:

```
CARBON DENSITY   VIRGIN=26.0  SPENT=32.0  LB/CUFT
VELOCITY                          6.0 GPM/SQFT
HEIGHT OF UNDERDRAIN              2.0 FEET
EFFLUENT COD                       1.0 MG/L
ADSORBER CAPACITY                 0.5 LB COD/LB CARBON
STORAGE REQUIRED                  7.0 DAYS
EMPTY BED RESIDENCE TIME          25.0 MIN
BACKWASH   RATE=12.0 GPM/SQFT  DURATION=15.0 MIN
FURNACE LOADING RATE              75.0 LB/DAY/SQFT
LENGTH TO WIDTH RATIO             2.0
```

c. Carbon adsorption unit process data cards are listed below:

CARBON ADSORPTION MOD xx

CARBON DENSITY VIRGIN = xx.x SPENT = xx.x LB/CU FT

VELOCITY xx.x GPM/SQ FT

HEIGHT OF UNDERDRAIN xx.x FEET

EFFLUENT COD xx.x MG/L

ADSORBER CAPACITY xx.x LB COD/LB CARBON

STORAGE REQUIRED xx.x DAYS

EMPTY BED RESIDENCE TIME xx.x MIN

BACKWASH RATE = xx.x GPM/SQ FT DURATION = xx.x MIN

FURNACE LOADING RATE xx.x LB/DAY/SQ FT

LENGTH TO WIDTH RATIO xx.x

ESTIMATE[a] COSTUD = xx.x COSTCG = xx.x COSTSF = xx.x
COSOIL = xx.x CPICC = xx.x COSTPS = xx.x $

REPLACEMENT[b] RSUD = xx.x RCG = xx.x RSF = xx.x
RSPS = xx.x RSST = xx.x YEARS

END

---

[a] COSTUD = Cost of underdrain system; default value = $\$35/\mathrm{ft}^2$. COSTCG = Unit price of a 3- by 6-ft control gate with operator and frame; default value = $17,300. COSTSF = Cost of 400-sq-ft hearth area furnace with controls, carbon feed system, combustion air flow, induced draft flow, scrubber, and dust control; default value = $825,000. COSOIL = Cost of fuel oil per gallon; default value = $0.75. CPICC = Cost of carbon per pound; default value = $0.56. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

[b] See Appendix F.

3-8. Cation Exchange.

a. Design parameters for cation exchange are listed below:

Treatment flow rate = 2-5 gpm/cu ft

Regenerant flow rate = 1-2 gpm/cu ft

Rinsing flow rate = 0.5-1.5 gpm/cu ft

Amount of rinse water = 30-120 gal/cu ft

Column depth = 24-30 in. minimum

Amount of backwash water = 30-100 gal/cu ft

Backwash water rate = 4.0-12.0 gpm/cu ft

Resin exchange capacity = lb/cu ft (consult manufacturer specifications)

Regenerant dose, level, concentration, and specific gravity (consult resin manufacturer specifications)

b. Default data are given below:

```
EFFLUENT CONCENTRATION                2          MG/L
RESIN EXCHANGE CAPACITY               4          LB/CFT
REGENERATE DOSE=12 LB/CFT   LEVEL=7.5 LB/CFT   CONC=7.5 PER   SG=1.04
FLOW RATES  TREAT=3   REGEN =1.5   RINSE=1.0     GPM/CFT
HOURS PER DAY                         8          HOURS
AMOUNT OF RINSE WATER                 50         G/CFT
COLUMN DEPTH                          24         INCHES
BACKWASH   AMOUNT=100.0 G/CFT   RATE=10 GPM/CFT
```

c. Cation exchange unit process data cards are listed below:

```
CATION EXCHANGE[a]           MOD xx

EFFLUENT CONCENTRATION                  xx.x          MG/L

RESIN EXCHANGE CAPACITY                 xx.x          LB/CU FT

REGENERANT DOSE = xx.x  LB/CU FT   LEVEL = xx.x       LB/CU FT
  CONC = xx.x PERCENT  SPECIFIC GRAVITY = xx.x

FLOW RATES TREAT = xx.x  REGEN = xx.x
  RINSE = xx.x                                        GPM/CU FT

HOURS PER DAY                           xx.x          HOURS

AMOUNT OF RINSE WATER                   xx.x          G/CU FT

COLUMN DEPTH                            xx.x          INCHES

BACKWASH AMOUNT = xx.x  G/CU FT  RATE = xx.x          GPM/CU FT

REPLACEMENT[b]                     RSST = xx.x        YEARS

END
```

---

[a] This unit process is parametrically costed.

[b] See Appendix F.

3-9. Centrifugation.

a. Design parameters for centrifugation are listed below:

Power requirement for centrifuge = 0.5-2.0 hp/gpm

Number of units will be adjusted if calculated horsepower per unit exceeds 200 hp

Excess capacity factors = 1.25

Chemical dosage = 1.0% of dry weight of solids (maximum)

b. Default data are given below:

```
POWER REQUIREMENT                        1.0        HPR/GPM
HOURS PER DAY                            8          HOURS
DAYS PER WEEK                            5          DAYS
NUMBER OF UNITS                          2.0        UNITS
EXCESS CAPACITY FACTOR                   1.25

CHEMICAL DOSE                            1          PERCENT DRY
```

c. Centrifugation unit process data cards are listed below:

CENTRIFUGATION	MOD xx	
POWER REQUIREMENT	xx.x	HPR/GPM
HOURS PER DAY	xx.x	HOURS
DAYS PER WEEK	xx.x	DAYS
NUMBER OF UNITS	xx.x	UNITS
EXCESS CAPACITY FACTOR	xx.x	
CHEMICAL DOSE	xx.x	PERCENT DRY WT
ESTIMATE[a]	COSTSC = xx.x	$
REPLACEMENT[b]	RSSC = xx.x RSST = xx.x	YEARS
END		

---

[a] COSTSC = Cost of standard 50-hp centrifuge; default value = $120,000.

[b] See Appendix F.

3-10. Charge Calculation Data.

a. Data for calculating user charges are listed below:

EPA grant is assumed to be 75% for conventional mechanical treatment systems; 85% for land treatment systems

State grant assumed as 0%

Allowance for financing represents extra cost associated with issuance of bonds

Revenue, general obligation, or other sources of interest-bearing funds may be specified as means of financing the local shore. These bonds or loans may have varying interest rates or life

Gallons per capita per day represents water usage and is assumed to be 100 gpcd

b. Default data are given below:

```
EPA GRANT                     75.0       85.0  PERCENT
ALLOWANCE FOR FINANCING                   3.0  PERCENT
REVENUE BONDS        100.0 %  10.0 %       30  YEARS
PERSONS PER HOUSEHOLD                     3.5
GALLONS PER CAPITA PER DAY              100.0  GPCPD
```

c. Charge calculations data cards are listed below:

CHARGE CALCULATIONS

EPA GRANT xx.x PERCENT xx.x LAND TREATMENT PERCENT

STATE GRANT xx.x PERCENT

ALLOWANCE FOR FINANCING xx.x PERCENT

REVENUE BONDS[a,b] PLS = xx.x I = xx.x N = xx.x

GENERAL OBLIGATION BONDS[a,b] PLS = xx.x I = xx.x N = xx.x

OTHER BONDS OR LOANS[a,b] PLS = xx.x I = xx.x N = xx.x

EXISTING BILLING INFORMATION[c] NUMBER OF BILLING UNITS xx.x BU
BILLING UNIT RATE xx.x $/BU

CURRENT SYSTEM ANNUAL OPERATION AND MAINTENANCE xx.x $/YEAR

PERSONS PER HOUSEHOLD xx.x

GALLONS/CAPITA/DAY xx.x GPCPD

END

---

[a] PLS = Percent of local share,
I = Interest rates,
N = Maturity in years.

[b] Any combination of these cards may be used. The sum of the percentages of the local share should be 100%.

[c] Usually based on water sold.

3-11. Chlorination.

a. Design parameters for chlorination are given below.

Contact time should not be less than 15 min at peak flow.

Typical chlorine dosages for disinfection and odor control are shown in Table 3-2.

Table 3-2. Typical Chlorine Dosages for Disinfection and Odor Control[a]

Effluent From	Dosage Range mg/ℓ
Untreated wastewater (prechlorination)	6 to 25
Primary sedimentation	5 to 20
Chemical precipitation plant	2 to 6
Trickling filter plant	3 to 15
Activated sludge plant	2 to 8
Multimedia filter following activated sludge plant	1 to 5

[a] Prepared by WES.

b. Default data are given below:

```
CONTACT TIME                    30        MIN
CHLORINE DOSE                   10        MG/L
```

c. Chlorination unit process data cards are listed below:

```
CHLORINATION              MOD xx

CONTACT TIME                            xx.x          MIN

CHLORINE DOSE                           xx.x          MG/L

ESTIMATE[a]   CHLCOST = xx.x $/TON   COSTCLE = xx.x

REPLACEMENT[b]   RSLE = xx.x   RSST = xx.x            YEARS

END
```

---

[a] CHLCOST = Cost of chlorine; default value = $100/ton.
COSTCLE = Cost of standard 2,000 lb/day chlorinator; default value = $2,700.

[b] See Appendix F.

3-12. Coagulation.

a. Design parameters for coagulation are listed below:

Coagulant	Coagulant Dose mg/ℓ	Optimum pH
Lime	200.0-500.0	10.0-11.0
Alum	50.0-100.0	5.0-6.5
Iron Salts	100.0-250.0	5.0-6.5

b. Default data are given below:

```
REMOVAL RATES  SS=90  BOD=60  COD=60  TKN=40  PO=50 PERCENT
UNDERFLOW CONCENTRATION             5.0 PERCENT
OPTIMIUM PH                         10.5
LIME                                250 MG/L
```

c. Coagulation unit process data cards:

COAGULATION MOD xx		
OPTIMUM PH	xx.x	
LIME DOSAGE[a]	xx.x	MG/L
ALUM DOSAGE[a]	xx.x	MG/L
IRON SALT DOSAGE[a]	xx.x	MG/L
REMOVAL SS = xx.x BOD = xx.x COD = xx.x TKN = xx.x PO = xx.x		PERCENT
UNDERFLOW CONCENTRATION	xx.x	PERCENT
ESTIMATE[b] COSTCL = xx.x		
REPLACEMENT[c] RSCL = xx.x RSST = xx.x		YEARS
END		

---

[a] Use only one of lime, alum, or iron salts cards; default value = lime.

[b] COSTCL = Cost of standard 60-ft-diam upflow clarifier; default value = $110,000.

[c] See Appendix F.

3-13. Comminution.

a. Default data for comminution are given below:

NUMBER OF UNITS	2

b. Comminution unit process data cards are listed below:

COMMINUTION[a]   MOD xx

NUMBER OF UNITS   xx.x

END[b]

---

[a] This process used with preliminary treatment.

[b] Replacement life is included with grit removal unit process.

3-14. Complete Mix Activated Sludge.

a. Design paramters for Eckenfelder's approach are listed below:

Parameter	Suggested Values
K	Reaction rate constant = 0.0007-0.002 ℓ/mg/hr
A	Fraction of BOD synthesized = 0.73
A'	Fraction of BOD oxidized for energy = 0.52
B	Endogenous respiration rate (sludge basis) = 0.075/day
B'	Endogenous respiration rate (oxygen basis) = 0.15/day
F	Nonbiodegradable fraction of volatile suspended solids (VSS) in influent = 0.40
F'	Degradable fraction of the mixed liquor volatile suspended solids (MLVSS) = 0.53
ALPHA	O_2 transfer in waste/O_2 transfer in water = 0.90
BETA	O_2 saturation in waste/O_2 saturation in water = 0.90
HPR	Horsepower per 1000 gallons $\geq$ 0.10 hp/1000 gal
F/M ratio	Food/microorganism ratio = 0.03-0.60
STE	Standard transfer efficiency Mechanical aerators = 2.0-3.5 lb O_2/hp-hr High speed = 2.0 Slow speed = 3.5 Diffused aerator = 6.0-11.0% Coarse bubble = 6.0 Fine bubble = 11.0

Additional parameters include:

Mixed liquor suspended solids (MLSS) = 3000-6000 mg/ℓ
Mixed liquor volatile solids (MLVS) = 2100-4200 mg/ℓ
Temperature correction coefficient = 1.0-1.04
Effluent BOD soluble = 10 mg/ℓ

b. Default data are given below:

```
CONSTANTS  K=0.00135 A=0.73 AP=0.52 B=0.075 BP=0.15 F=0.4 FP=0.53
F/M RATIO                         0.5        LB BOD/LB VSS
MIXED LIQUOR    SS=4500    VS=3150           MG/L
TEMPERATURE COEFFICIENT           1.035
EFFLUENT BOD SOLUBLE              10         MG/L
DIFFUSED AERATION ALPHA=0.9 BETA=0.9 AF=20.0 CM/TG STE=6   PERCENT
```

c. Complete mix activated sludge unit process data cards are listed below:

COMPLETE MIX ACTIVATED SLUDGE[a] MOD xx

CONSTANTS K = xx.x A = xx.x A' = xx.x B = xx.x B' = xx.x
F = xx.x F' = xx.x

F/M RATIO xx.x LB BOD/LB VSS

MIXED LIQUOR SS = xx.x VS = xx.x MG/L

TEMPERATURE COEFFICIENT xx.x

EFFLUENT BOD SOLUBLE xx.x MG/L

MECHANICAL AERATION[b] ALPHA = xx.x BETA = xx.x
HPR = xx.x HPR/TG STE = xx.x LB O/HPR-HR

DIFFUSED AERATION[b] ALPHA = xx.x BETA = xx.x
AF[c] = xx.x CFM/TCUFT STE = xx.x PERCENT

ESTIMATE[d] SSXSA = xx.x COSTPD = xx.x COSTPH = xx.x
COSTPS = xx.x

REPLACEMENT[e] RSSA = xx.x RSPD = xx.x RSPH = xx.x
RSPS = xx.x RSST = xx.x YEARS

END

---

[a] User must also specify secondary clarification (activated sludge).

[b] Use mechanical or diffused, not both; default value = diffused. If mechanical aeration is specified, all data on mechanical card must be input.

[c] AF (minimum airflow) specifies a lower limit on airflow. Model will calculate actual airflow and compare it with input value. Higher value will be output. Input zero for AF to obtain calculated value only.

[d] SSXSA = Cost of standard slow-speed, pier-mounted 20-hp aerator; default value = $16,300. COSTPD = Cost of standard 12.0-scfm coarse-bubble diffuser; default value = $6.50. COSTPH = Cost of standard 550-scfm swing arm diffuser; default value = $5,000. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

[e] See Appendix F.

3-15. Contact Stabilization Activated Sludge.

a. Design parameters for contact stabilization activated sludge are given below:

Contact time
  Contact tank = 0.5-1.0 hr
  Stabilization tank = 2.0-4.0 hr

Mixed liquor SS
  Contact tank = 2500-3500 mg/ℓ
  Stabilization tank = 4000-8000 mg/ℓ

Percent volatile = 70%

Oxygen required = 1.25-1.50 lb O_2/lb BOD removed/day

Sludge production = 0.2-0.4 lb solids/lb BOD removed/day

Effluent BOD soluble = 10 mg/ℓ

Additional parameters include:

Parameter	Suggested Values
F'	Degradable fraction of VSS = 0.53
ALPHA	O_2 transfer in waste/O_2 transfer in water = 0.90
BETA	O_2 saturation in waste/O_2 saturation in water = 0.90
HPR	Horsepower per 1000 gal $\geq$ 0.10 hp/1000 gal
STE	Standard transfer efficiency Mechanical aerators = 2.0-3.5 lb O_2/hp-hr High speed = 2.0 Slow speed = 3.5 Diffused aerator = 6.0-11.0% Coarse bubble = 6.0 Fine bubble = 11.0

b. Default data are given below:

```
AERATION TIME CONTACT 1.0    STABILIZATION  3    HOURS
MIXED LIQUOR   SS   CONTACT=3000   STABILIZATION=6000      MG/L
PERCENT VOLATILE                   70          PERCENT
OXYGEN REQUIRED                    1.25        LB O/LB BOD/DAY
SLUDGE PRODUCTION                  0.3         LB/LB BOD/DAY
CONSTANTS                          FP=0.5
EFFLUENT BOD SOLUBLE               10          MG/L
DIFFUSED AERATION ALPHA=0.9 BETA=0.9 AF=20.0 CM/T6 STE=6   PERCENT
```

c. Contact stabilization activated sludge unit process data cards are listed below:

CONTACT STABILIZATION ACTIVATED SLUDGE[a] MOD xx

AERATION TIME CONTACT = xx.x STAB BASIN = xx.x HOURS

MIXED LIQUOR SS CONTACT = xx.x STAB BASIN = xx.x MG/L

PERCENT VOLATILE xx.x PERCENT

OXYGEN REQUIRED xx.x LB O/LB BOD/DAY

SLUDGE PRODUCTION xx.x LB SOLID/LB BOD/DAY

CONSTANT F' = xx.x

EFFLUENT BOD SOLUBLE xx.x MG/L

MECHANICAL AERATION[b] ALPHA = xx.x BETA = xx.x
HPR = xx.x HPR/TG STE = xx.x LB O/HPR-HR

DIFFUSED AERATION[b] ALPHA = xx.x BETA = xx.x
AF[c] = xx.x CFM/TCUFT STE = xx.x PERCENT

ESTIMATE[d] SSXSA = xx.x COSTPD = xx.x COSTPH = xx.x
COSTPS = xx.x

REPLACEMENT[e] RSSA = xx.x RSPD = xx.x RSPH = xx.x
RSPS = xx.x RSST = xx.x YEARS

END

---

[a] User must also specify secondary clarification (activated sludge).

[b] Use mechanical or diffused, not both; default value = diffused. If mechanical aeration is specified, all data on mechanical card must be input.

[c] AF (minimum airflow) specifies a lower limit on airflow. Model will calculate actual airflow and compare it with input value. Higher value will be output. Input zero for AF to obtain calculated value only.

[d] SSXSA = Cost of standard slow-speed, pier-mounted 20-hp aerator; default value = $16,300. COSTPD = Cost of standard 12.0-scfm coarse-bubble diffuser; default value = $6.50. COSTPH = Cost of standard 550-scfm swing arm diffuser; default value = $5,000. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

[e] See Appendix F.

3-16. Cost Overrides.

a. Within the unit process specification input section, the user has the option of supplying unit process costs which are deemed to be more accurate than those which will be generated by CAPDET. Data coding for these cost overrides consists of a cost header card followed by one data card for each unit process for which the user wishes to supply costs. Cost overrides may be supplied for a maximum of 30 unit processes. The input of unit process cost overrides will be terminated with an END card.

b. The unit process will be identified by the unit process keyword as listed on pages 2-6 through 2-9. The right cost override data items which may be included for each unit process are as follows:

(1) The modification number: The modification number must be specified even if modification zero is used.

(2) Capital cost of the unit process in present-day dollars.

(3) Annual operational man-hours in man-hours per year.

(4) Annual maintenance man-hours in man-hours per year.

(5) Annual power cost in present-day dollars per year.

(6) Annual supply cost in present-day dollars per year.

(7) Annual chemical cost in present-day dollars per year.

(8) Design life (replacement schedule) in years. If the design life is omitted (or input as zero), the design life of the treatment plant (as specified on the GO card) will be used.

c. The COSTS section is loaded with the value of -1.0 in all eight data items. These values are simply space fillers which represent no cost override options. To override CAPDET cost estimates, the user would substitute the eight items for the -1.0 values.

EXAMPLE

```
COST OVERRIDES (header card)

AERATED LAGOON         0     -1   -1   -1  -1  1200  -1  30

CHLORINATION           1  86870  700  400   0     0   0

PRIMARY CLARIFICATION  0      0    0    0   0     0   0   0

END
```

This example illustrates three unit processes which will use the cost override option. For the aerated lagoon modification zero, only the annual supply cost is overriden. A design life of 30 years will be used for the lagoon. For the modification one chlorination unit, the CAPDET values for capital cost, operation man-hours, and maintenance man-hours will be overridden with the values $86870 and 700 and 400 man-hours per year, respectively. Annual power cost, supply cost, and chemical cost are zero, and the replacement schedule of the chlorination unit will be equal to the treatment plant life. For the primary clarification modification zero unit process, all items are overridden with zeros. This may be an existing unit where it is necessary to evaluate the characteristics of the waste stream through the existing facility, but it is unnecessary to include the unit process in the system cost evaluation.

d. Cost override data cards are listed below:

Key Word	MOD Number	Capital Cost, $	Operation Man-Hours Hr/Year	Maint Man-Hours Hr/Year	Power Cost $/Year	Supply Cost $/Year	Chemical Cost $/Year	Design Life Years
COSTS[a,b]								
A SECONDARY CLARIFICATION (ACTIVATED SLUDGE)	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
AERATED LAGOON	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
AEROBIC DIGESTION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
AIR FLOTATION THICKENING	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
ANAEROBIC DIGESTION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
ANION EXCHANGE	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
ATTACHED GROWTH DENITRIFICATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
BELT FILTER	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
CARBON ADSORPTION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
CATION EXCHANGE	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
CENTRIFUGATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
CHLORINATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
CLARIFICATION (USER-SPECIFIED)	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
COAGULATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
COMPLETE MIX ACTIVATED SLUDGE	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
CONTACT STABILIZATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
COUNTER CURRENT AMMONIA STRIPPING	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
CROSS CURRENT AMMONIA STRIPPING	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
D SECONDARY CLARIFICATION (SUSPENDED GROWTH DENITRIFICATION)	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
DENITRIFICATION (SUSPENDED GROWTH)	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
DRYING BEDS	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
DUMMY PROCESS	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
EQUALIZATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
EXTENDED AERATION ACTIVATED SLUDGE	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
FILTRATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
FIRST STAGE RECARBONATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
FLUIDIZED BED INCINERATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x

---

[a] List only those lines describing the unit process whose cost functions are to be replaced.

[b] If all values are not changed in a line, the other values must be reset to -1.0.

Key Word	MOD Number	Capital Cost, $	Maint Man- Operation Man-Hours Hr/Year	Hours Hr/ Year	Power Cost $/Year	Supply Cost $/Year	Chemical Cost $/Year	Design Life Years
FLOCCULATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
FLOTATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
FLTR PRESS	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
GRAVITY THICKENING	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
GRIT REMOVAL & COMMINUTORS	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
HAULING AND LAND FILLING	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
HIGH RATE ACTIVATED SLUDGE	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
L PRIMARY CLARIFICATION (LIME TREATMENT)	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
LAGOONS	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
MICROSCREENING	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
MULTIPLE HEARTH INCINERATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
N SECONDARY CLARIFICATION (NITRIFICATION - SUSPENDED GROWTH)	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
NEUTRALIZATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
NITRIFICATION (SUSPENDED GROWTH)	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
N RBC (NITRIFICATION)	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
N TRICKLING FILTER (NITRIFICATION)	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
OVERLAND FLOW LAND TREATMENT	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
OXIDATION DITCH	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
O SECONDARY CLARIFICATION (OXIDATION DITCH)	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
PLUG FLOW ACTIVATED SLUDGE	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
POSTAERATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
PRIMARY CLARIFICATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
PURE OXYGEN ACTIVATED SLUDGE	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
P SECONDARY CLARIFICATION (PURE OXYGEN)	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
RAPID INFILTRATION LAND TREATMENT	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
RAW SEWAGE PUMPING	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
RBC	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
R SECONDARY CLARIFICATION (RBC)	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
RECARBONATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
PUMPING (INTERMEDIATE)	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
SECOND STAGE RECARBONATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
SLUDGE LAGOONS	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
SLOW INFILTRATION LAND TREATMENT	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
STEP AERATION ACTIVATED SLUDGE	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
T SECONDARY CLARIFICATION (TRICKLING FILTER)	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
TRICKLING FILTRATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
VACUUM FILTRATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
WET OXIDATION	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
END								

3-17. Counter Current Ammonia Stripping.

a. Design parameters for counter current ammonia stripping are listed below:

Liquid loading rate = 500-1000 lb water/hr/sq ft

Gas loading rate = 2-4 times liquid loading rate (consult manufacturer for packing characteristics)

Lime dosage = 200-500 mg/ℓ

Height of transfer unit (consult manufacturer specifications)

Ammonia concentration in air at top of tower = 0.02-0.05 mg/ℓ

Desired effluent quality = 2.0-8.0 mg/ℓ

b. Default data are given below:

```
DESIRED EFFLUENT QUALITY                2.0         MG/L
LIQUID LOADING RATE                     600         LB/HR/SQFT
GAS LOADING RATE                        1800        LB/HR/SQFT
LIME DOSE                               200         MG/L
HEIGHT OF TRANSFER UNIT                 15          FEET
AMMONIA CONCENTRATION IN AIR LEAVING TOWER  0.03          MG/L
```

c. Counter current ammonia stripping unit process data cards are listed below:

```
COUNTER CURRENT AMMONIA STRIPPING[a]     MOD xx

DESIRED EFFLUENT QUALITY                    xx.x     MG/L

LIQUID LOADING RATE                         xx.x     LB/HR/SQ FT

GAS LOADING RATE                            xx.x     LB/HR/SQ FT

LIME DOSE                                   xx.x     MG/L

HEIGHT OF TRANSFER UNIT                     xx.x     FT

AMMONIA CONCENTRATION IN AIR TOP
  OF TOWER                                  xx.x     MG/L

REPLACEMENT[b]                       RSST = xx.x     YEARS

END
```

---

[a] This unit process is parametrically costed.

[b] See Appendix F.

3-18. Cross Current Ammonia Stripping.

a. Design parameters for cross current ammonia stripping are given below:

Liquid loading rate = 500-1000 lb water/hr/sq ft

Gas loading rate = 2-4 times liquid loading rate (consult manufacturer for packing characteristics)

Lime dosage = 200-500 mg/ℓ

Height of transfer unit (consult manufacturer specifications)

Desired effluent quality = 2.0-8.0 mg/ℓ

b. Default data are given below:

```
DESIRED EFFLUENT QUALITY              2.0      MG/L
LIQUID LOADING RATE                   600      LB/HR/SQFT
GAS LOADING RATE                      1800     LB/HR/SQFT
LIME DOSE                             200      MG/L
HEIGHT OF TRANSFER UNIT               15       FT
```

c. Cross current ammonia stripping unit process data cards are listed below:

CROSS CURRENT AMMONIA STRIPPING[a]	MOD xx	
DESIRED EFFLUENT QUALITY	xx.x	MG/L
LIQUID LOADING RATE	xx.x	LB/HR/SQ FT
GAS LOADING RATE	xx.x	LB/HR/SQ FT
LIME DOSE	xx.x	MG/L
HEIGHT OF TRANSFER UNIT	xx.x	FT
REPLACEMENT[b]	RSST = xx.x	YEARS
END		

---

[a] This unit process is parametrically costed.

[b] See Appendix F.

3-19. Denitrification (Suspended Growth).

a. Design parameters for denitrification (suspended growth) are listed below:

Mixed liquor suspended solids = 1000-2000 mg/ℓ

Mixed liquor volatile suspended solids = 800-1600 mg/ℓ

Methanol requirement = 3 lb methanol/lb influent nitrate

Alkalinity production = 3 mg/mg nitrate removed

Gross yield of denitrifier = 0.6-1.2 lb VSS/lb nitrate removed

Half-saturation constant K_o = 0.16 mg/ℓ

Decay coefficient K_d = 0.04/day

Detention time in stabilization tank = 1 hr

Power requirement for stabilization tank = 1-2 hp/1000 gal

Sludge return ratio = 1.0

b. Default data are given below:

```
ALLOWABLE EFFLUENT NITRATE             5.0 MG/L
DISSOLVED OXYGEN (INFLUENT)            2.0 MG/L
ALKALINITY (INFLUENT)                  3.0 MG/L
MIXED LIQUOR   SS=1200   VSS=960   MG/L
METHANOL REQUIREMENT                   3.0 LB/LB NITRATE
PRODUCTION OF ALKALINITY               3.0 MG/MG NITRATE
GROSS YIELD OF DENITRIFIER             0.9 LB/LB NITRATE
CONSTANTS   KO=0.16 MG/L   KD=0.04 /DAY
DETENTION TIME (STABILIZATION TANK) 1.0 HOURS
POWER REQUIREMENT                      0.1 HPR/T GAL
SLUDGE RETURN RATIO                    1.0
EFFLUENT SOLUBLE BOD                   8.0 MG/L
```

c. Denitrification (suspended growth) unit process data cards are listed below:

DENITRIFICATION (SUSPENDED GROWTH)[a] MOD xx

ALLOWABLE EFFLUENT NITRATE xx.x MG/L

DISSOLVED OXYGEN (INFLUENT) xx.x MG/L

ALKALINITY (INFLUENT) xx.x MG/L

MIXED LIQUOR SS = xx.x VSS = xx.x MG/L

METHANOL REQUIREMENT xx.x LB/LB NITRATE

PRODUCTION OF ALKALINITY xx.x MG/MG NITRATE

GROSS YIELD OF DENITRIFIER xx.x LB/LB NITRATE

CONSTANTS KO = xx.x MG/L KD = xx.x /DAY

DETENTION TIME (STAB TANK) xx.x HOURS

POWER REQUIREMENT xx.x HPR/TGAL

SLUDGE RETURN RATIO xx.x

EFFLUENT SOLUBLE BOD xx.x MG/L

ESTIMATE[b] SSXSA = xx.x SSXM = xx.x COSTPS = xx.x
COSTFM = xx.x

REPLACEMENT[c] RSSA = xx.x RSXM = xx.x RSPS = xx.x
RSST = xx.x YEARS

END

---

[a] User must also specify secondary clarification (denitrification).

[b] SSXSA = Cost of slow-speed, pier-mounted 20-hp aerator; default value = $16,300. SSXM = Cost of 5-hp vertical turbine mixer; default value = $7,750. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250. COSTFM = Cost of methanol; default value = $0.15/lb.

[c] See Appendix F.

3-20. Denitrification (Attached Growth).

a. Design parameters for denitrification (attached growth) are listed below:

Methanol requirement = 3 lb methanol/lb influent nitrate

Alkalinity production = 3 mg/mg nitrate removed

Specific surface of media = 20-75 sq ft/cu ft

Application rate = 0.5-1.0 gpm/sq ft of column area

Backwash rate = 12 gpm/sq ft

Minimum media depth > 8 ft

b. Default data are given below:

```
ALLOWABLE EFFLUENT NITRATE          3.0 MG/L
METHANOL REQUIREMENT                3.0 LB/LB NITRATE
ALKALINITY PRODUCTION               3.0 MG/MG NITRATE
SPECIFIC SURFACE OF MEDIA          41.0 SQFT/CUFT
APPLICATION RATE                    0.75 GPM/SQFT
BACKWASH RATE                      12.0 GPM/SQFT
MINIMUM MEDIA DEPTH                12.0 FEET
```

c. Denitrification (attached growth) unit process data cards are listed below:

ATTACHED GROWTH DENITRIFICATION MOD xx

ALLOWABLE EFFLUENT NITRATE xx.x MG/L

METHANOL REQUIREMENT xx.x LB/LB NITRATE

ALKALINITY PRODUCTION xx.x MG/MG NITRATE

SPECIFIC SURFACE OF MEDIA xx.x SQ FT/CU FT

APPLICATION RATE xx.x GPM/SQ FT

BACKWASH RATE xx.x GPM/SQ FT

MINIMUM MEDIA DEPTH xx.x FEET

ESTIMATE[a] CMOST = xx.x CDOST = xx.x COSTPS = xx.x
COSTFM = xx.x

REPLACEMENT[b] RSCD = xx.x RSPS = xx.x RSST = xx.x YEARS

END

---

[a] CMOST = Unit cost of media; default value = \$3/cu ft. CDOST = Unit cost of distribution system and effluent weir troughs; default value = \$40/sq ft of cross-sectional area. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = \$17,250. COSTFM = Cost of methanol; default value = \$0.15/lb.

[b] See Appendix F.

3-21. Drying Beds.

a. Design parameters for drying beds are listed below:

Depth of sludge applied = 8-12 in.

Time to drain = T days = 2

Drained solids content after T days = 15-25%

Final solids content = 30-50%

Evaporation rate (available from U. S. Weather Bureau)

Rainfall during wet month (available from U. S. Weather Bureau)

Correction for evaporation rate for sludge = 0.75

Fraction of rainfall absorbed by sludge = 0.57

b. Default data are given below:

```
DEPTH                                  12 INCHES
TIME TO DRAIN                           2 DAYS
FINAL SOLIDS                           50 PERCENT
DRAIN SOLIDS                           20 PERCENT
EVAPORATION RATE                        5 IN/MO
RAINFALL                                3 IN/MO
CORRECTION FOR EVAPORATION           0.75
FRACTION ABSORBED                    0.57
```

c. Drying beds unit process data cards are listed below:

DRYING BEDS	MOD xx	
DEPTH APPLIED	xx.x	INCHES
TIME TO DRAIN	xx.x	DAYS
DRAINED SOLIDS	xx.x	PERCENT
FINAL SOLIDS	xx.x	PERCENT
EVAPORATION RATE	xx.x	IN/MO
RAINFALL	xx.x	IN/MO
CORRECTION FOR EVAPORATION	xx.x	
FRACTION ABSORBED	xx.x	

ESTIMATE[a] PIPE COSTS = xx.x xx.x xx.x COSAND = xx.x
COGRVL = xx.x

REPLACEMENT[b] RSCP = xx.x RSST = xx.x YEARS

END

---

[a] Pipe costs for 4-, 6-, and 8-in. perforated clay pipe in place, \$/FT; default values = \$2.15, \$2.75, and \$4.25 per foot, respectively. COSAND = Cost of sand in place, \$/cu yd; default value = \$5.90. COGRVL = Cost of gravel in place, \$/cu yd; default value = \$4.30.

[b] See Appendix F.

3-22. Dummy Process.

a. In certain situations, the user may wish to adjust the waste characteristics at some point within the train (to simulate side flows, new processes, etc.). For these cases, the DUMMY process is available. The DUMMY process is a liquid line process and is listed on the BLOCK card with the key word DUMMY. The data cards for the DUMMY process are shown on the following page. The parameters of flow, temperature, and pH are set to describe the waste stream at that point in the train. All other waste characteristic parameters are modified as percent reductions of that particular parameter from the value it possessed as influent to the DUMMY process. The cost data are user input and the data card is of the same format as the cost override card. The sludge lines can be modified to indicate sludge production at that point in the train by inputting values for volume of sludge, percent solids of sludge, and volatile portion of the sludge. If the sludge cards are included, all three values must be present and in the proper order.

b. The values Q_i, C_i, T_i, and pH_i are waste descriptors that are either input by the user, if it is at the head of the plant, or are effluent characteristics generated by the flow through previous processes. Since for the DUMMY process there is no standard design and cost formulation within CAPDET, the user must simulate the effect of the process on the waste stream. This is done by setting Q_i, T_i, pH_i, sludge volumes, and costs and describing the C_e's as percent reductions of the C_i's.

c. Dummy process data cards are listed below:

Key Word	Value	Units
DUMMY PROCESS		
MINIMUM FLOW	xx.x	MGD
AVERAGE FLOW FINAL xx.x INITIAL	xx.x	MGD
MAXIMUM FLOW	xx.x	MGD
TEMPERATURE SUMMER xx.x WINTER	xx.x	DEG C
SUSPENDED SOLIDS	xx.x	PER RED
VOLATILE SOLIDS	xx.x	PER RED
BOD5	xx.x	PER RED
SBOD (SOLUBLE)	xx.x	PER RED
COD xx.x	PER RED	
SCOD (SOLUBLE)	xx.x	PER RED
PH xx.x	UNITS	
CATIONS	xx.x	PER RED
ANIONS	xx.x	PER RED
TKN xx.x	PER RED	
PO4 xx.x	PER RED	
NH3 xx.x	PER RED	
SETTLEABLE SOLIDS	xx.x	PER RED
OIL AND GREASE	xx.x	PER RED
NO2 xx.x	PER RED	
NO3 xx.x	PER RED	
PRIMARY SLUDGE xx.x GAL/DAY xx.x PER SOLIDS xx.x PER VOLATILE		
SECONDARY SLUDGE xx.x GAL/DAY xx.x PER SOLIDS xx.x PER VOLATILE		
COSTS CAPITAL xx.x OPER MAN HRS xx.x MAINT MAN HRS xx.x POWER xx.x SUPPLY COST xx.x CHEMICAL COSTS xx.x DESIGN LIFE xx.x		
REPLACEMENT[a]	RSST = xx.x	YEARS
END		

---

[a] See Appendix F.

3-23. Equalization.

a. Design parameters for equalization are listed below:

Parameter	Suggested Values
ALPHA	O_2 transfer in waste/O_2 transfer in water = 0.9
BETA	O_2 saturation in waste/O_2 saturation in water = 0.9
HPR	Aerator mixing requirements = 0.02-0.04 hp/ 1000 gal
STE	Standard transfer efficiency = 5.0 lb O_2/hp-hr

Additional parameters include:

Oxygen requirements = 15.0 mg/ℓ/hr

Pressure correction coefficient = 1.0

Dissolved oxygen to be maintained in basin = 2.0 mg/ℓ

Depth of basin > 5.0 ft due to aerator operation

b. Default data are given below:

```
MECHANICAL AERATION ALPHA=0.9 BETA=0.9 HPR=0.03 HPR/TG STE=5.0 LB O/HPR/HR
OXYGEN REQUIREMENTS            15.0 MG/L/HOUR
PRESSURE COEFFICIENT           1.0
SUMMER TEMPERATURE             23 DEG C
DISSOLVED OXYGEN               2.0 MG/L
DEPTH OF BASIN                 6.0 FEET
EARTHEN BASIN                  0.30 $/SQFT
```

c. Equalization unit process data cards are listed below:

```
EQUALIZATION    MOD  xx

MECHANICAL AERATION    ALPHA  = xx.x  BETA = xx.x
  HPR = xx.x     STE = xx.x

OXYGEN REQUIREMENTS                                   xx.x      MG/L/HR

PRESSURE COEFFICIENT                                  xx.x

SUMMER TEMPERATURE                                    xx.x      DEG C

DISSOLVED OXYGEN                                      xx.x      MG/L

DEPTH OF BASIN                                        xx.x      FEET

FLOWS[a,b]   xx.x    xx.x    xx.x    xx.x    xx.x               GAL/HR

VOLUME OF BASIN[b]                                    xx.x      MG

CONCRETE BASIN[c]

EARTHEN BASIN[c,d]   LINER COST = xx.x  $/SQ FT   RSLL = xx.x  YEARS

ESTIMATE[e]      COSTSA = xx.x

REPLACEMENT[d]    RSSA = xx.x   RSST = xx.x                     YEARS

END
```

---

[a] More than one FLOW card may be used. Any number of hourly flows may be included on each FLOW card. A maximum of 24 hourly flows may be input.

[b] Use either FLOW cards or a VOLUME card to determine the required volume of the basin. If neither are specified, the volume will be defaulted to 20 percent of the average flow.

[c] Use earthen lined or concrete lined, not both; default value = earthen lined.

[d] RSLL = Service life of liner. See Appendix F.

[e] COSTSA = Cost of standard 50-hp, high-speed floating aerator; default value = $13,960.

3-24. Extended Aeration Activated Sludge.

a. Design parameters for Eckenfelder's approach are listed below:

Parameter	Suggested Values
K	Reaction rate constant = 0.0007-0.002 ℓ/mg/hr
A	Fraction of BOD synthesized = 0.73
A'	Fraction of BOD oxidized for energy = 0.52
B	Endogenous respiration rate (sludge basis) = 0.075/day
B'	Endogenous respiration rate (oxygen basis) = 0.15/day
F	Nonbiodegradable fraction of VSS in influent = 0.40
F'	Degradable fraction of the MLVSS = 0.53
A_0	Fraction of BOD5 synthesized to degradable solids = 0.77a = 0.56
ALPHA	O_2 transfer in waste/O_2 transfer in water = 0.90
BETA	O_2 saturation in waste/O_2 saturation in water = 0.90
HPR	Horsepower per 1000 gal $\geq$ 0.10 hp/1000 gal
F/M ratio	Food/microorganism ratio = 0.05-0.15
STE	Standard transfer efficiency Mechanical aerators = 2.0-3.5 lb O_2/hp-hr High speed = 2.0 Slow speed = 3.5 Diffused aerator = 6.0-11.0% Coarse bubble = 6.0 Fine bubble = 11.0

Additional parameters include:

Mixed liquor suspended solids = 3000-6000 mg/ℓ
Mixed liquor volatile solids = 2100-4200 mg/ℓ
Temperature correction coefficient = 1.0-1.04
Effluent BOD soluble = 10 mg/ℓ

b. Default data are given below:

```
CONSTANTS    K=0.0012 A=0.73 AP=0.52 B=0.075 BP=0.15 F=0.4 FP=0.53 AO=0.56
F/M RATIO                          0.1          LB BOD/LB VSS
MIXED LIQUOR     SS=3500   VS=2500              MG/L
TEMPERATURE COEFFICIENT            1.03
EFFLUENT BOD SOLUBLE              10            MG/L
DIFFUSED AERATION ALPHA=0.9 BETA=0.9 AF=20.0 CM/TG STE=6   PERCENT
```

c. Extended aeration activated sludge unit process data cards are listed below:

EXTENDED AERATION ACTIVATED SLUDGE[a]   MOD xx

CONSTANTS K = xx.x A = xx.x A' = xx.x B = xx.x B' = xx.x
F = xx.x F' = xx.x AO = xx.x

F/M RATIO   xx.x   LB BOD/LB VSS

MIXED LIQUOR SS = xx.x VS = xx.x   MG/L

TEMPERATURE COEFFICIENT   xx.x

EFFLUENT BOD SOLUBLE   xx.x   MG/L

MECHANICAL AERATION[b] ALPHA = xx.x BETA = xx.x
HPR = xx.x HPR/TG STE = xx.x LB O/HPR-HR

DIFFUSED AERATION[b] ALPHA = xx.x BETA = xx.x
AF[c] = xx.x CFM/TCUFT STE = xx.x PERCENT

ESTIMATE[d] SSXSA = xx.x COSTPD = xx.x COSTPH = xx.x
COSTPS = xx.x

REPLACEMENT[e] RSSA = xx.x RSPD = xx.x RSPH = xx.x
RSPS = xx.x RSST = xx.x   YEARS

END

---

[a] User must also specify secondary clarification (activated sludge).

[b] Use mechanical or diffused, not both; default value = diffused. If mechanical aeration is specified, all data on mechanical card must be input.

[c] AF (minimum airflow) specifies a lower limit on airflow. Model will calculate actual airflow and compare it with input value. Higher value will be output. Input zero for AF to obtain calculated value only.

[d] SSXSA = Cost of standard slow-speed, pier-mounted 20-hp aerator; default value = \$16,300. COSTPD = Cost of standard 12.0-scfm coarse-bubble diffuser; default value = \$6.50. COSTPH = Cost of standard 550-scfm swing arm diffuser; default value = \$5,000. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = \$17,250.

[d] See Appendix F.

3-25. Filter Press.

a. Design parameters for filter press are listed below:

Cake solids content (see Table 3-3)

Density of cake = 65.0 lb/cu ft

Chamber volume (see manufacturer specifications)
= 1.0-2.0 cu ft

Hours operation per day = 8-16 hr

Cycle time of filter (see Table 3-3)

Table 3-3. Sludge Concentration Produced by Filter Presses[a]

Type of Sludge	Cycle Time hr	Cake Solids percent
Primary	1.5-3.0	40.0-50.0
Raw (primary + activated)	2.0-4.5	30.0-40.0
Digested (primary + activated)	2.0-4.0	35.0-45.0
Activated sludge	2.0-6.0	24.0-40.0
Low lime sludge	2.0-4.0	35.0-45.0
Alum sludge	1.0-4.0	25.0-40.0
Heat-treated sludge	1.5-3.0	45.0-60.0

[a] Courtesy of American Society of Civil Engineers and the Water Pollution Control Federation (1977).

b. Default data are given below:

```
CAKE SOLIDS CONTENT                45.0 PERCENT
DENSITY OF CAKE                    65.0 LB/CUFT
CHAMBER VOLUME                      2.0 CUFT
HOURS OF OPERATION                  8.0 HOURS
CYCLE TIME                          2.0 HOURS
CONDITIONING MATERIAL               5.0 PERCENT
```

c. Filter press unit process data cards are listed below:

FLTR PRESS[a]	MOD xx	
CAKE SOLIDS CONTENT	xx.x	PERCENT
DENSITY OF CAKE	xx.x	LB/CU FT
CHAMBER VOLUME	xx.x	CU FT
HOURS OPERATION PER DAY	xx.x	HOURS
CONDITIONING MATERIAL	xx.x	PERCENT
CYCLE TIME	xx.x	HOURS
REPLACEMENT[b]	RSST = xx.x	YEARS
END		

---

[a] This unit process is parametrically costed.

[b] See Appendix F.

3-26. Filtration.

a. Design parameters (for general design characteristics see Table 3-4) are listed below:

Filter media characteristics (see Table 3-5)

Loading rate, dual media = 2-10 gpm/sq ft; multimedia = 2-12 gpm/sq ft

Sixty percent finer size of the sand = 0.75 mm

Density of water = 62.4 lb/cu ft

Viscosity of water = 1.009 centipoises

Porosity of unexpanded bed = 0.40

Additional parameters include:

Parameter	Suggested Values
K	Coefficient of permeability = 6
POR	Porosity = 0.50 for anthracite and 0.40 for sand
DIA	Particle diameter or effective size (Table 3-5)
SF	Shape factor = 6.0 for spherical or 8.5 for crushed granules
SG	Specific gravity = 1.4-1.6 for anthracite or 2.65 for sand

b. Default data are given below:

```
LOADING RATE                          6.0        G/M/SQFT
APPROACH VELOCITY                     0.005    FT/SEC
LAYERS      NUMBER=4  (FOLLOW WITH ONE CARD PER LAYER TOP TO BOTTOM)
D=1.00 K=6 POR=0.50 DIA=0.0046 SF=7.0 SG=1.40     (ANTHRACITES)
D=1.00 K=5 POR=0.40 DIA=0.0020 SF=8.5 SG=2.65     (SAND)
D=1.00 K=4 POR=0.47 DIA=0.0010 SF=8.0 SG=2.65     (GARNET SANDS)
D=1.00 K=6 POR=0.60 DIA=0.0500 SF=6.0 SG=2.65     (GRAVEL)
SIXTY PERCENT FINER SIZE              0.75     MM
SPECIFIC WEIGHT OF SAND               165.4    LB/CFT
DENSITY OF WATER                      62.4     LBM/CUFT
POROSITY OF BED                       0.4
EXPANDED DEPTH                        5        FEET
NUMBERS OF TROUGHS                    50       THOUGHS
WIDTH OF TROUGHS                      1        FEET
UNDERDRAIN DEPTH                      1        FEET
HEAD LOSS IN UNDERDRAIN               1        FEET
OPERATING DEPTH OF WATER ABOVE SAND            3        FEET
HEIGHT OF TROUGH FROM UNDERDRAIN      6.5      FEET
BACKWASH TIME                         10       MINUTES
FREEBOARD                             1        FEET
ABSOLUTE VISCOSITY OF WATER           1.0087   CENTIPOISES
```

c. Filtration unit process data cards are listed below:

FILTRATION MOD xx		
LOADING RATE	xx.x	G/MSQ FT
APPROACH VELOCITY	xx.x	FT/SEC
LAYERS[a] NUMBER = xx.x		
D = xx.x FT K = xx.x POR = xx.x DIA = xx.x FT SF = xx.x SG = xx.x		
SIXTY PERCENT FINER SIZE	xx.x	MM
SPECIFIC WEIGHT OF SAND	xx.x	LB/CU FT
DENSITY OF WATER	xx.x	LB/CU FT
KINEMATIC VISCOSITY[b]	xx.	SQ FT/SEC
POROSITY OF BED	xx.x	
EXPANDED DEPTH	xx.x	FT
NUMBER OF TROUGHS	xx.x	
WIDTH OF TROUGHS	xx.x	FT
UNDERDRAIN DEPTH	xx.x	FT
HEAD LOSS IN UNDERDRAIN	xx.x	FT
OPERATING DEPTH OF WATER ABOVE SAND	xx.x	FT
HEIGHT OF TROUGH FROM UNDERDRAIN	xx.x	FT
BACKWASH TIME	xx.x	MIN
FREEBOARD	xx.x	FT
ABSOLUTE VISCOSITY OF WATER	xx.x	CENTIPOISES
ESTIMATE[c] COSF = xx.x COSTPS = xx.x		
REPLACEMENT[d] RSSF = xx.x RSPS = xx.x RSST = xx.x YEARS		
END		

---

[a] The LAYERS card must be followed immediately with one card per layer in the order of top to bottom. These cards have no key word. They must contain the depth (ft), permeability, porosity, mean diameter (ft), shape factor, and specific gravity for the layers in the order shown.

[b] Kinematic viscosity will be calculated if this card is omitted.

[c] COSF = Cost of standard 784-sq-ft filter unit; default value = $165,000. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

[d] See Appendix F.

Table 3-4. General Features of Construction and Operation of Conventional Slow and Rapid Sand Filters[a]

Feature	Slow Sand Filters	Rapid Sand Filters
Filter rate	1 to 3 to 10 mgad	100 to 125 to 300 mgad
Size of bed	Large, half acre	Small, 1/100 to 1/10 acre
Depth of bed	12 in. of gravel; 42 in. of sand, usually reduced to no less than 24 in. by scraping	18 in. of gravel; 30 in. of sand or less; not reduced by washing
Size of sand	Effective size 0.25 to 0.3 to 0.35 mm; coefficient of nonuniformity 2 to 2.5 to 3	0.45 mm and higher; coefficient of nonuniformity 1.5 and lower, depending on underdrainage system
Grain-size distribution of sand in filter	Unstratified	Stratified with smallest or lightest grains at top and coarsest or heaviest at bottom
Underdrainage system	Split tile laterals laid in coarse stone and discharging into tile or concrete main drains	(1) Perforated pipe laterals discharging into pipe mains; (2) porous plates above inlet box; (3) porous blocks with included channels
Loss of head	0.2 ft initial to 4 ft final	1 ft initial to 8 or 9 ft final
Length of run between cleanings	20 to 30 to 60 days	12 to 24 hr
Penetration of suspended matter	Superficial	Deep

(Continued)

---

[a] Prepared by Fair, Geyer, and Okum (1968), courtesy of John Wiley and Sons.

Table 3-4 (Concluded)

Feature	Slow Sand Filters	Rapid Sand Filters
Method of cleaning	(1)Scraping off surface layer of sand, washing and storing cleaned sand for periodic resanding of bed; (2) washing surface sand and sand in place by washer traveling over sand bed	Dislodging and removing suspended matter by upward or back-washing, which fluidizes the bed. Possible use of water or air jets, or mechanical rakes to improve scour
Amount of wash water used in cleaning sand	0.2 to 0.6 percent of water filtered	1 to 4 to 6 percent of water filtered
Preparatory treatment of water	Generally none	Coagulation, flocculation, and sedimentation
Supplementary treatment of water	Chlorination	Chlorination
Cost of construction, U. S.	Relatively high	Relatively low
Cost of operation	Relatively low where sand is cleaned in place	Relatively high
Depreciation cost	Relatively low	Relatively high

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Table 3-5. Typical Design Data for Dual-Media and Multimedia Filters[a]

Characteristic	Value	
	Range	Typical
Dual Media		
Anthracite		
Depth, in.	8 to 24	18.0
Effective size, mm	0.8 to 2.0	1.2
Uniformity coefficient	1.4 to 1.8	1.5
Sand		
Depth, in.	10 to 24	12.0
Effective size, mm	0.3 to 0.8	0.5
Uniformity coefficient	1.2 to 1.6	1.4
Filtration rate, gpm/ft^2	2 to 10	6.0
Multimedia		
Anthracite		
Depth, in.	8 to 20	15.0
Effective size, mm	1.0 to 2.0	1.4
Uniformity coefficient	1.4 to 1.8	1.5
Sand		
Depth, in.	8 to 16	12.0
Effective size, mm	0.4 to 0.8	0.6
Uniformity coefficient	1.2 to 1.6	1.4
Garnet[b]		
Depth, in.	2 to 4	3.0
Effective size, mm	0.2 to 0.6	0.3
Uniformity coefficient		1.0
Filtration rate, gpm/ft^2	2 to 12	6.0

---

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering; Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972, by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

[b] Garnet becomes intermixed with sand and anthracite.

3-27. Flocculation.

a. Design parameters for flocculation are listed below:

Lime dosage (determine from jar test) = 200-500 mg/ℓ

Optimum pH (determine from jar test) = 10-11

Detention time for flash mix basin = 1.0-3.0 min

Detention time for flocculator basin = 15.0-60.0 min

b. Default data are given below:

```
LIME                              DOSE=250  MG/L
DETENTION TIME   FLASH MIX=3   FLOCCULATOR=45    MIN
OPTIMUM PH                        10.5
```

c. Flocculation unit process data cards are listed below:

FLOCCULATION[a]		MOD xx	
LIME DOSE		xx.x	MG/L
DETENTION TIME	FLASH MIX = xx.x	FLOCCULATOR = xx.x	MIN
OPTIMUM PH		xx.x	
REPLACEMENT[b]		RSST = xx.x	YEARS
END			

---

[a] This unit process is parametrically costed.

[b] See Appendix F.

3-28. Flotation.

a. Design parameters for flotation are given below:

Air pressure = 40-70 psig

Detention time in float tank = 0.25-0.5 hr

Solid loading (determine from laboratory tests)

Hydraulic loading = 1.0-4.0 gal/min/sq ft

Recycle time in pressure tank = 1.0-3.0 min

Percent removal of solids (determine from bench test) = 80.0

Air/solids ratio (determine from laboratory test)

Float concentration (determine from bench test) = 3.0-5.0%

Removal of BOD (determine from bench test)

Removal of COD (determine from bench test)

Removal of TKN (determine from bench test)

b. Default data are given below:

```
AIR PRESSURE                       40        PSIG
DETENTION TIME IN FLOAT TANK       0.5       HRS
SOLID LOADING                      15        LB/SQFT/DAY
HYDRAULIC LOADING                  3.5       GPM/SQFT
RECYCLE TIME IN PRESS TANK         3.0       MIN
PERCENT REMOVAL OF SOLIDS          80        PERCENT
AIR/SOLIDS RATIO                   0.02
FLOAT CONCENTRATION                3         PERCENT
REMOVAL   BOD=30   COD=30   TKN=10           PERCENT
```

c. Flotation unit process data cards are listed below:

FLOTATION	MOD	xx	
AIR PRESSURE[a]		xx.x	PSIG
DETENTION TIME IN FLOAT TANK		xx.x	HRS
SOLID LOADING		xx.x	LB/SQ FT/DAY
HYDRAULIC LOADING		xx.x	GPM/SQ FT
RECYCLE TIME IN PRESSURE TANK[a]		xx.x	MIN
PERCENT REMOVAL OF SOLIDS		xx.x	PERCENT
AIR/SOLIDS RATIO		xx.x	
FLOAT CONCENTRATION		xx.x	PERCENT
REMOVAL BOD = xx.x COD = xx.x TKN = xx.x			PERCENT
ESTIMATE[b] COSTFS = xx.x			
REPLACEMENT[c] RSFS = xx.x RSST = xx.x			YEARS
END			

---

[a] Use with recycle only.

[b] COSTFS = Cost of standard 350-sq-ft air flotation unit; default value = $44,200.

[c] See Appendix F.

3-29. Fluidized Bed Incineration.

a. Design parameters for fluidized bed incineration are listed below:

Sludge analysis (determine from bench tests)
Carbon content = 59.8%
Hydrogen content = 8.4%
Oxygen content = 27.5%
Sulfur content = 1.0%

Fuel analysis (use reported values for desired fuel; typical values for fuel oil are provided)
Carbon content = 87.3%
Hydrogen content = 12.6%
Oxygen content = 0.0%
Sulfur content = 1.0%

Heat value of fuel (use reported value for desired fuel), for fuel oil = 18,000 Btu/lb

Operating temperature of preheater unit = 1000-1200°F

Sand to sludge ratio = 3.0-8.0

Detention time = 10.0-60.0 sec

b. Default data are given below:

```
HOURS PER DAY                  8 HOURS
DAYS PER WEEK                  5
SLUDGE ANALYSIS         C=59.8  H=8.4  O=27.5  S=1.0
FUEL ANALYSIS           C=87.3  H=12.6  O=0.0  S=1.0
HEAT VALUE OF FUEL         18000 BTU/LB
OPERATING TEMPERATURE        1000 DEGREES F
AMBIENT TEMPERATURE            75 DEGREES F
SAND TO SLUDGE RATIO           6.0 LB/LB
SPECIFIC WEIGHT OF SAND         110 LB/CUFT
DETENTION TIME                 15 SECONDS
```

c. Fluidized bed incineration unit process data cards are listed below:

```
FLUIDIZED BED INCINERATION     MOD  xx

HOURS PER DAY                  xx.x

DAYS PER WEEK                  xx.x

SLUDGE ANALYSIS[a]  C = xx.x  H = xx.x  O = xx.x
   S = xx.x                                        PERCENT

FUEL ANALYSIS[a]    C = xx.x  H = xx.x  O = xx.x
   S = xx.x                                        PERCENT

HEAT VALUE OF FUEL             xx.x                BTU/LB

OPERATING TEMPERATURE          xx.x                DEG F

AMBIENT TEMPERATURE            xx.x                DEG F

SAND TO SLUDGE RATIO           xx.x

SPECIFIC WEIGHT OF SAND        xx.x                LB/CU FT

DETENTION TIME                 xx.x                SECONDS

ESTIMATE[b]  COSTFI = xx.x     COSOIL =   xx.x

REPLACEMENT[c]  RSFI = xx.x    RSST = xx.x         YEARS

END
```

---

[a] C = Carbon content; H = Hydrogen content; O = Oxygen content; S = Sulfur content.

[b] COSTFI = Cost of standard 15-ft-diam incinerator; default value = $1,100,000. COSOIL = Cost of fuel oil per gallon; default value = $0.75.

[c] See Appendix F.

3-30. Gravity Thickening.

a. Design parameters for gravity thickening are listed below:

Underflow concentration (determine from bench test)

Mass loading rate (see Table 3-6)

Settling velocity (determine from lab test with results similar to Figure 3-2) = 48.0-72.0 ft/day

Initial height = 4.0-8.0 ft

Intercept (determine from lab test with results similar to Figure 3-2) = 3.0 ft

Table 3-6. Concentrations of Unthickened and Thickened Sludges and Solids Loadings for Mechanical Thickeners[a]

Type of Sludge	Sludge, Solid, Percent		Solids Loading for Mechanical Thickeners lb/sq ft/day
	Unthickened	Thickened	
Separate sludges			
Primary	2.5 to 5.5	8.0 to 10.0	20 to 30
Trickling filter	4.0 to 7.0	7.0 to 9.0	8 to 10
Modified aeration	2.0 to 4.0	4.3 to 7.9	7 to 18
Activated	0.5 to 1.2	2.5 to 3.3	4 to 18
Combined sludges			
Primary and trickling filter	3.0 to 6.0	7.0 to 9.0	12 to 20
Primary and modified aeration	3.0 to 4.0	8.3 to 11.6	12 to 20
Primary and activated	2.6 to 4.8	4.6 to 9.0	8 to 16

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering; Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972, by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

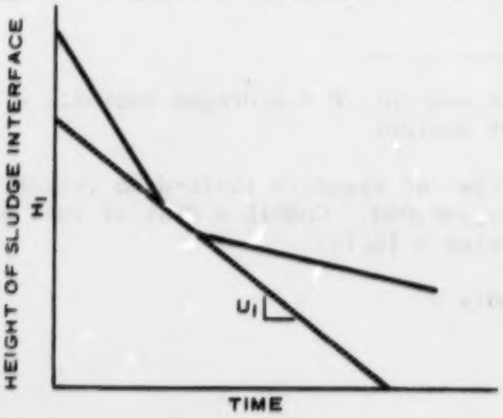

Figure 3-2. Typical settling curve from laboratory test (prepared by WES)

b. Default data are given below:

```
UNDERFLOW CONCENTRATION          5      PERCENT
MASS LOADING                     10     LB/SQFT/DAY
DEPTH                            9      FEET
```

c. Gravity thickening unit process data cards are listed below:

GRAVITY THICKENING	MOD	xx	
UNDERFLOW CONCENTRATION		xx.x	PERCENT
MASS LOADING[a]		xx.x	LB/SQ FT/DAY
DEPTH		xx.x	FT
SETTLING VELOCITY[a]		xx.x	FT/DAY
INITIAL HEIGHT[a]		xx.x	FT
INTERCEPT[a]		xx.x	FT
ESTIMATE[b]	COSTTS = xx.x		
REPLACEMENT[c]	RSTS = xx.x	RSST = xx.x	YEARS
END			

---

[a] List either mass loading or the three parameters: settling velocity, initial height, and intercept; not both.

[b] COSTTS = Cost of standard 90-ft-diam thickener; default value = $82,500.

[c] See Appendix F.

3-31. Grit Removal.

a. Design parameters for grit removal are listed below:

Specific gravity of particles = 2.65

Particle size (see Table 3-7)

Current allowance = 1.70

Manning coefficient = 0.03

Aerated grit chamber design parameters
- Air supply = 3 cfm/ft of tank length
- Air diffusers located 2-3 ft above tank bottom on one side of tank
- Surface velocity = 1.5-2 fps
- Tank floor velocity = 1-1.5 fps
- Grit collectors = airlift pumps to decanting channels, grit conveyors or grit pumps
- Detention time = 2-3 min
- Efficiency = 100% removal of 65-mesh grit

Table 3-7. Grit Settling Velocities[a]

Particle Size		Settling Velocity			Area Required
Mesh	mm	ft/min	gpd/ft^2	mgd/ft^2	ft^2/million gal
18	0.833	14.7	160,000	0.1600	6.3
20	0.595	10.5	114,500	0.1145	8.7
35	0.417	7.4	80,100	0.0801	12.5
48	0.295	5.2	56,700	0.0567	17.7
65[b]	0.208	3.7	40,000	0.0400	25.0
100	0.147	2.6	28,200	0.0282	35.5
150	0.105	1.8	20,200	0.0202	49.5

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering: Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972 by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

[b] Minimum particle size desirable for removal.

b. Default data are given below:

```
PARTICLE SIZE                          0.2       MM
SPECIFIC GRAVITY                       2.65
AERATED                     VMAX=1.50 VAVE=1.00  FPS
DETENTION TIME         2.5 MIN
AIR SUPPLY             3.0 CFM/FT
NUMBER OF UNITS                        2
DEPTH                                  4         FT
CURRENT ALLOWANCE                      1.7
MANNING COEFFICIENT                    0.035
VOLUME OF GRIT                         4         CFT/MG
```

c. Grit removal unit process data cards are listed below:

GRIT REMOVAL[a]	MOD xx		
PARTICLE SIZE		xx.x	MM
SPECIFIC GRAVITY		xx.x	
HORIZONTAL FLOW[b]	VMAX = xx.x	VAVG = xx.x	FPS
AERATED[b]	VMAX = xx.x	VAVG = xx.x	FPS
NUMBER OF UNITS		xx.x	
DEPTH[c]		xx.x	FT
WIDTH[c]		xx.x	FT
CURRENT ALLOWANCE		xx.x	
MANNING COEFFICIENT		xx.x	
VOLUME OF GRIT		xx.x	CFT/MG
DETENTION TIME[d]		xx.x	MIN
AIR SUPPLY[d]		xx.x	CFM/FT
ESTIMATE[e]			
REPLACEMENT[f]		RSST = xx.x	YEARS
END			

---

[a] This process is part of preliminary treatment.

[b] Use horizontal flow or aerated, not both; default value = aerated.

[c] Use depth or width card, not both; default value = depth.

[d] Use with aerated flow only.

[e] The ESTIMATE card in grit removal specifies estimate pricing for preliminary treatment which includes grit removal, comminutors, and bar screens.

[f] See Appendix F.

3-32. High Rate Activated Sludge.

a. Design parameters for Eckenfelder's approach are listed below:

Parameter	Suggested Values
K	Reaction rate constant = 0.0007-0.002 ℓ/mg/hr
A	Fraction of BOD synthesized = 0.73
A'	Fraction of BOD oxidized for energy = 0.52
B	Endogenous respiration rate (sludge basis) = 0.075/day
B'	Endogenous respiration rate (oxygen basis) = 0.15/day
F	Nonbiodegradable fraction of VSS in influent = 0.40
F'	Degradable fraction of the MLVSS = 0.53
ALPHA	O_2 transfer in waste/O_2 transfer in water = 0.90
BETA	O_2 saturation in waste/O_2 saturation in water = 0.90
HPR	Horsepower per 1000 gal $\geq$ 0.10 hp/1000 gal
F/M ratio	Food/microorganism ratio = 1.5-5.0
STE	Standard transfer efficiency Mechanical aerators = 2.0-3.5 lb O_2/hp-hr High speed = 2.0 Slow speed = 3.5 Diffused aerator = 6.0-11.0% Coarse bubble = 6.0 Fine bubble = 11.0

Additional parameters include:

Mixed liquor suspended solids = 4,000-10,000 mg/ℓ
Mixed liquor volatile solids = 3,200-8,000 mg/ℓ
Temperature correction coefficient = 1.0-1.04
Effluent BOD soluble = 10 mg/ℓ

b. Default data are given below:

```
CONSTANTS  A=0.73 AP=0.52 B=0.075 BP=0.15 F=0.4 FP=0.53
F/M RATIO                         2.0       LB BOD/LB VSS
MIXED LIQUOR    SS=6000   VS=4500             MG/L
TEMPERATURE COEFFICIENT           1.035
EFFLUENT BOD SOLUBLE              10        MG/L
DIFFUSED AERATION ALPHA=0.9 BETA=0.9 AF=20.0 CM/TG STE=6  PERCENT
```

c. High rate activated sludge unit process data cards are listed below:

```
HIGH RATE ACTIVATED SLUDGE[a]      MOD xx

CONSTANTS  A = xx.x  A' = xx.x  B = xx.x
  B' = xx.x  F = xx.x  F' = xx.x

F/M RATIO                            xx.x              LB BOD/LB VSS

MIXED LIQUOR  SS = xx.x  VS = xx.x                     MG/L

TEMPERATURE COEFFICIENT              xx.x

EFFLUENT BOD SOLUBLE                 xx.x              MG/L

MECHANICAL AERATION[b]     ALPHA = xx.x  BETA = xx.x
  HP = xx.x  HPR/TG   STE = xx.x   LB O/HPR-HR

DIFFUSED AERATION[b]      ALPHA = xx.x  BETA = xx.x
  AF[c] = xx.x  CFM/TCUFT  STE = xx.x  PERCENT

ESTIMATE[d]  SSXSA = xx.x  COSTPD = xx.x  COSTPH = xx.x
  COSTPS = xx.x

REPLACEMENT[e]  RSSA = xx.x  RSPD = xx.x  RSPH = xx.x
  RSPS = xx.x  RSST = xx.x                               YEARS

END
```

---

[a] User must also specify secondary clarification (activated sludge).

[b] Use mechanical or diffused, not both; default value = diffused. If mechanical aeration is specified, all data on mechanical card must be input.

[c] AF (minimum airflow) specifies a lower limit on airflow. Model will calculate actual airflow and compare it with input value. Higher value will be output. Input zero for AF to obtain calculated value only.

[d] SSXSA = Cost of standard slow-speed, pier-mounted 20-hp aerator; default value = $16,300. COSTPD = Cost of standard 12.0-scfm coarse-bubble diffuser; default value = $6.50. COSTPH = Cost of standard 550-scfm swing arm diffuser; default value = $5,000. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

[e] See Appendix F.

3-33. Lagoons.

a. Design parameters for lagoons are presented in Table 3-8:

Table 3-8. Design Parameters for Stabilization Ponds[a]

Parameter	Type of Pond			
	Aerobic[b]	Facultative	Facultative	Anaerobic
Flow regime	Intermittently mixed	--	Mixed surface layer	--
Pond size, acres	<10 multiples	2 to 10 multiples	2 to 10 multiples	0.5 to 2.0 multiples
Operation[c]	Series or parallel	Series or parallel	Series or parallel	Series
Detention time, days[c]	10 to 40	7 to 30	7 to 20	20 to 50
Depth, ft	3 to 4	3 to 6	3 to 8	8 to 15
pH	6.5 to 10.5	6.5 to 9.0	6.5 to 8.5	6.8 to 7.2
Temperature range, °C	0 to 40	0 to 50	0 to 50	6 to 50
Optimum temperature, °C	20	20	20	30
BOD_5 loading, lb/acre/day[d]	60 to 120[e]	15 to 50	30 to 100	200 to 500
BOD_5 conversion	60 to 70	60 to 70	60 to 70	50 to 70
Principal conversion products	Algae, CO_2, bacterial cell tissue	Algae, CO_2, CH_4, bacterial cell tissue	CO_2, CH_4, bacterial cell tisue	CO_2, CH_4, bacterial cell tissue
Algal concentration, mg/ℓ	80 to 200	40 to 160	10 to 40	--
Effluent suspended solids, mg/ℓ[f]	140 to 340	160 to 400	110 to 340	80 to 160

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering; Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972, by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

[b] Conventional aerobic ponds designed to maximize the amount of oxygen produced rather than the amount of algae produced.

[c] Depends on climatic conditions.

[d] Typical values (much higher values have been applied at various loadings). Loading values are often specified by state control agencies.

[e] Some states limit this figure to 50 or less.

[f] Includes algae, microorganisms, and residual influent suspended solids. Values are based on an influent soluble BOD_6 of 200 mg/ℓ and, with the exception of the aerobic ponds, an influent suspended-solids concentration of 200 mg/ℓ.

b. Default data are given below:

```
BOD LOADING                             50.0 LB/ACRE/DAY
DEPTH                                   3.0 FEET
AEROBIC LAGOON
```

c. Lagoon unit process data cards are listed below:

LAGOON MOD xx.x

BOD LOADING RATE xx.x LB/ACRE/DAY

DEPTH OF LAGOON xx.x FEET

LINER REQUIRED[a,b] UPILL xx.x $/SQ FT RSLL = xx.x YEARS

AEROBIC LAGOON[c]

FACULTATIVE LAGOON[c]

ANAEROBIC LAGOON[c]

ESTIMATE[d] COSTSP = xx.x COSTSV = xx.x

REPLACEMENT[b] RSSP = xx.x RSSV = xx.x RSST = xx.x YEARS

END

---

[a] If no liner card is input, lagoon will be unlined. UPILL = cost of installed liner in $/sq ft; default value = unlined.

[b] RSLL = Service life of liner. See Appendix F.

[c] Use only one of aerobic, facultative, or anaerobic; default value = aerobic.

[d] COSTSP = Cost of 12-in.-diam welded steel pipe; default value = $12.80/ft. COSTSV = Cost of 12-in.-diam butterfly valve; default value = $952.10/value.

3-34. Microscreening.

a. Design parameters for microscreening are listed below:

Hydraulic loading rate = 5-10 gpm/sq ft of submerged screen area.

Washwater required = 3-5 percent of the applied flow

b. Default data are given below:

```
HYDRAULIC LOADING RATE                7.0 GPM/SQFT
REMOVAL SS=60.0 BOD=50.0 COD=50.0 TKN=50.0 PO=50.0 PERCENT
WASH WATER REQUIRED                   4.0 PERCENT
```

c. Microscreening unit process data cards are listed below:

MICROSCREENING MOD xx

HYDRAULIC LOADING RATE xx.x GPM/SQ FT

REMOVAL SS = xx.x BOD = xx.x COD = xx.x
TKN = xx.x PO = xx.x PERCENT

WASHWATER REQUIRED xx.x PERCENT

ESTIMATE[a] COSTSM = xx.x

REPLACEMENT[b] RSSM = xx.x RSST = xx.x YEARS

END

---

[a] COSTSM = Cost of standard 108-sq-ft microscreen; default value = $52,000.

[b] See Appendix F.

3-35. Multiple Hearth Incineration.

a. Design parameters for multiple hearth incineration are listed below:

Wet sludge loading rate = 7.0-12.0 lb/hr/sq ft
at 20-25% total solids

b. Default data are given below:

WET SLUDGE LOADING RATE	10.0 LB/HR/SQFT
DAYS PER YEAR OPERATION	260.0 DAYS

c. Multiple hearth incineration unit process data cards are listed below:

MULTIPLE HEARTH INCINERATION MOD xx

WET SLUDGE LOADING RATE xx.x LB/HR/SQ FT

DAYS PER YEAR OPERATION xx.x DAYS

ESTIMATE[a] COSTIS = xx.x COSOIL = xx.x

REPLACEMENT[b] RSIS = xx.x RSST = xx.x YEARS

END

---

[a] COSTIS = Cost of standard 1,580-sq-ft incinerator; default value = $1,190,000. COSOIL = Cost of fuel oil per gallon; default value = $0.75.

[b] See Appendix F.

3-36. Neutralization.

a. Design parameters for neutralization are listed below:

Buffer capacity (determine from titration curves) = pound of reagent per gallon of waste required to neutralize the waste to the desired pH

Degree of mixing (see manufacturer specifications) = 0.2-4.0 hp/1000 gal.

Mixing time (see manufacturer specifications) = 5.0-10.0 min

b. Default data are given below:

BUFFER CAPACITY	0.1	LB/GAL
DEGREE OF MIXING	0.3	HPR/TG
MIXING TIME	5	MIN

c. Neutralization unit process data cards are listed below:

NEUTRALIZATION[a] MOD xx		
BUFFER CAPACITY	xx.x	LB/GAL
DEGREE OF MIXING	xx.x	HPR/TG
MIXING TIME	xx.x	MIN
REPLACEMENT[b]	RSST = xx.x	YEARS
END		

---

[a] This unit process is parametrically costed.

[b] See Appendix F.

3-37. Nitrification (Suspended Growth).

a. Design parameters for nitrification (suspended growth) are listed below:

Decay coefficient = 0.05/day

Heterotrophic yield coefficient = 0.65 lb VSS grown/lb BOD_5 removed

Influent alkalinity as $CaCO_3$, in mg/ℓ

Metabolic factor = 15/hr at 20°C

Effluent ammonia soluble (consult National Pollutant Discharge Elimination System (NPDES) permit)

Additional parameters include:

Parameter	Suggested Values
ALPHA	O_2 transfer in waste/O_2 transfer in water = 0.90
BETA	O_2 saturation in waste/O_2 saturation in water = 0.90
HPR	Horsepower per 1000 gal ≥ 0.10 hp/1000 gal
STE	Standard transfer efficiency Mechanical aerators = 2.0-3.5 lb O_2/hp-hr High speed = 2.0 Slow speed = 3.5 Diffused aerator = 6.0-11.0% Coarse bubble = 6.0 Fine bubble = 11.0

b. Default data are given below:

```
TEMPERATURE  SUMMER  23.0    WINTER  10.0   DEG C
EFFLUENT AMMONIA  SUMMER  2.0    WINTER  5.0  MG/L
DECAY COEFFICIENT                    0.05 /DAY
HETEROTROPHIC YIELD COEFFICIENT      0.65 LB VSS/LB BOD
METABOLIC FACTOR                     15.0 /HOUR
DIFFUSED AERATION ALPHA=0.9 BETA=0.9 AF=20.0 STE=6.0 P=1.0
ALKALINITY (INFLUENT)                300.0 MG/L
```

c. Nitrification (suspended growth) unit process data cards are listed below:

NITRIFICATION (SUSPENDED GROWTH)[a] MOD xx

TEMPERATURE SUMMER = xx.x WINTER = xx.x DEG C

EFFLUENT AMMONIA SUMMER = xx.x WINTER = xx.x MG/L

DECAY COEFFICIENT xx.x /DAY

HETEROTROPHIC YIELD COEFFICIENT xx.x LB VSS/ LB BOD

METABOLIC FACTOR xx.x /HOUR

DIFFUSED AERATION[b] ALPHA = xx.x BETA = xx.x
AF[c] = xx.x CFM/TG STE = xx.x PERCENT P = xx.x

MECHANICAL AERATION[b] ALPHA = xx.x BETA = xx.x
HP = xx.x HPR/TG STE = xx.x LB O/HPR-HR

ALKALINITY (INFLUENT) xx.x MG/L

ESTIMATE[d] SSXSA = xx.x COSTPD = xx.x COSTPH = xx.x
COSTPS = xx.x

REPLACEMENT [e] RSSA = xx.x RSPD = xx.x RSPH = xx.x
RSPS = xx.x RSST = xx.x YEARS

END

---

[a] User must also specify secondary clarification (nitrification - suspended growth).

[b] Use mechanical or diffused, not both; default value = diffused. If mechanical aeration is specified, all data on mechanical card must be input.

[c] AF (minimum airflow) specifies a lower limit on airflow. Model will calculate actual airflow and compare it with input value. Higher value will be output. Input zero for AF to obtain calculated value only.

[d] SSXSA = Cost of standard slow-speed, pier-mounted 20-hp aerator; default value = $16,300. COSTPD = Cost of standard 12.0-scfm coarse-bubble diffuser; default value = $6.50. COSTPH = Cost of standard 550-scfm swing arm diffuser; default value = $5,000. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

[e] See Appendix F.

3-38. Nitrification (Rotating Biological Contactor).

a. Design parameters for nitrification (rotating biological contactor) are listed below:

Influent alkalinity as $CaCO_3$, in mg/ℓ

b. Default data are given below:

```
TEMPERATURES        SUMMER=23 DEG C    WINTER=10 DEG C
EFFLUENT AMMONIA      SUMMER=2.0 MG/L   WINTER=5.0 MG/L
ALKALINITY  (INFLUENT)               300 MG/L
```

c. Nitrification (rotating biological contactor) unit process data cards are listed below:

```
N RBC      MOD xx

TEMPERATURE  SUMMER = xx.x  WINTER = xx.x                 DEG C

EFFLUENT AMMONIA   SUMMER = xx.x   WINTER = xx.x           MG/L

ALKALINITY (INFLUENT)  xx.x                                MG/L

ESTIMATE[a] COSTES = xx.x

REPLACEMENT[b]   RSES = xx.x   RSST = xx.x                 YEARS

END
```

---

[a] COSTES = Cost of standard size media, shaft, and fiberglass cover for a shaft with surface area of 100,000 sq ft; default value = $34,500.

[b] See Appendix F.

3-39. <u>Nitrification (Trickling Filter)</u>.

a. Design parameters for nitrification (trickling filter) are listed below:

Influent alkalinity as $CaCO_3$, in mg/ℓ

Specific surface = a high specific surface media may be used. Typical value = 41 sq ft/cu ft

Surface loading rate = 0.75 gpm/sq ft

b. Default data are given below:

```
TEMPERATURE SUMMER  23.0  WINTER 10.0  DEG C
EFFLUENT AMMONIA  SUMMER  2.0   WINTER 5.0  MG/L
SPECIFIC SURFACE AREA              41.0 SQFT/CUFT
SURFACE LOADING RATE               0.75 GPM/SQFT
ALKALINITY  (INFLUENT)             300.0 MG/L
```

c. Nitrification (trickling filter) unit process data cards are listed below:

N TRICKLING FILTER MOD xx

TEMPERATURE SUMMER = xx.x WINTER = xx.x DEG C

EFFLUENT AMMONIA SUMMER = xx.x WINTER = xx.x MG/L

SPECIFIC SURFACE xx.x SQ FT/CU FT

SURFACE LOADING RATE xx.x GPM/SQ FT

ALKALINITY (INFLUENT) xx.x MG/L

ESTIMATE[a] UPFM = xx.x CODAS = xx.x COSTPS = xx.x

REPLACEMENT[b] RSFM = xx.x RSAS = xx.x
RSPS = xx.x RSST = xx.x YEARS

END

---

[a] UPFM = Cost of selected plastic media per cubic foot, installed; default value = $2.50/cu ft. CODAS = Cost of standard 5-ft-diam distributor arm; default value = $39,000. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

[b] See Appendix F.

3-40. Overland Flow Land Treatment.

a. Design parameters for overland flow land treatment are given below:

Application rate = 2.5-6.0 in./wk (screened wastewater)

Application rate = 6.0-16.0 in./wk (lagoon or secondary effluent)

Desired nitrate percolate = 0.1-10.0 mg/ℓ

Desired BOD percolate = 0.1-30.0 mg/ℓ

Runoff (site dependent) = 0.0 in./wk

Spray evaporation (percent of application rate) = 2.0-8.0%

Percolate of soil (percent of application rate) = 2.0-8.0%

Buffer zone (site dependent) = 0.0-500.0 ft

Slope = 2.0-8.0% (over 8.0% requires finished slopes)

Fraction of nitrogen loading denitrified = 75.0-90.0% (percent of total applied N)

Ammonia volatilization = 0.0 (percent of total applied N)

b. Default data are given below:

```
FORAGE GRASSES                          0.0   $/ACRE
APPLICATION RATE (HYDRAULIC)            3.5   IN/WEEK
DESIRED EFFLUENT (MAXIMUM)  NITRATE    10.0 MG/L
PRECIPITATION RATE                      0.8   IN/WEEK
EVAPOTRANSPIRATION RATE                 0.4   IN/WEEK
WASTEWATER GENERATION PERIOD          365.0   DAYS/YR
FIELD APPLICATION PERIOD               52.0   WEEKS/YR
SPRAY EVAPORATION RATE                  5.0   PERCENT
PERCOLATE RATE OF SOIL                  5.0   PERCENT
STORAGE REQUIRED                       30.0   DAYS/YEAR
OPEN CHANNEL RECOVERY SYSTEM
BUFFER ZONE                             0.0   FEET
CURRENT GROUND COVER   FOREST  20.0 %  BRUSH 30.0 %  PASTURE 50.0%
SLOPE                                   2.0   PERCENT
MONITORING WELLS                      5 WELLS AT 10 FT/WELL
FENCING                                2.75   $/FT
FRACTION DENITRIFIED                   90.0   PERCENT OF APPLIED N
AMMONIA VOLATILIZATION                  0.0   PERCENT OF APPLIED N
DAYS PER WEEK OPERATION                 7.0   DAYS/WEEK
HOURS PER DAY OPERATION                 8.0   HOURS/DAY
```

c. Overland flow land treatment unit process data cards are listed below:

OVERLAND FLOW LAND TREATMENT MOD xx		
APPLICATION RATE	xx.x	IN/WK
DESIRED EFFLUENT (MAXIMUM) NITRATE	xx.x	MG/L
PRECIPITATION RATE	xx.x	IN/WK
EVAPOTRANSPIRATION RATE	xx.x	IN/WK
WASTEWATER GENERATION PERIOD	xx.x	DAYS/YR
FIELD APPLICATION PERIOD	xx.x	WEEKS/YR
SPRAY EVAPORATION	xx.x	PERCENT
PERCOLATE OF SOIL	xx.x	PERCENT
STORAGE REQUIRED	xx.x	DAYS/YR
LINER REQUIRED[a,b] UPILL = xx.x $/SQ FT RSLL = xx.x		YEARS
EMBANKMENT PROTECTION[a,b] CSBA = xx.x $/CU YD RSBA = xx.x		YEARS
GRAVITY PIPE RECOVERY SYSTEM[c]		
OPEN CHANNEL RECOVERY SYSTEM[c]		
BUFFER ZONE WIDTH	xx.x	FT
CURRENT GROUND COVER FOREST = xx.x% BRUSH = xx.x% PASTURE = xx.x%		
SLOPE OF LAND	xx.x	PERCENT
MONITORING WELLS NO = xx.x DEPTH/WELL = xx.x		FT
FENCING[b] COSFN = xx.x $/FT RSFN = xx.x $/FT		
FRACTION DENITRIFIED	xx.x	PERCENT
AMMONIA VOLATILIZATION	xx.x	PERCENT
HOURS PER DAY OPERATION	xx.x	HOURS
DAYS PER WEEK OPERATION	xx.x	DAYS
FORAGE REVENUE = xx.x $/ACRE/YEAR		
ESTIMATE[d] PS = xx.x SP = xx.x SV = xx.x CS = xx.x CG = xx.x MW = xx.x SC = xx.x		
REPLACEMENT[b] RSPS = xx.x RSSP = xx.x RSSV = xx.x RSCS = xx.x RSMW = xx.x RSSC = xx.x RSST = xx.x		YEARS
END		

---

[a] UPILL = cost of installed liner; RSLL = liner life; CSBA = cost of embankment protection; RSBA = life of embankment protection.

[b] See Appendix F. RSFN = Service life of fence.

[c] Use gravity pipe or open channel, not both; default value = open channel.

[d] PS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250. SP = Cost of 12-in. welded steel pipe, in place; default value = $12.80/ft. SV = Cost of 12-in. butterfly valve; default value = $952.10. CS = Cost of 6- to 15-gpm impact-type full circle sprinkler; default value = $61.65. CG = Cost of clearing and grubbing; default value = $3,000/acre (assumed for heavy clearing and grubbing). MW = Cost of 4-in. water well; default value = $8.00/ft. SC = Cost of 24-in. reinforced concrete drainpipe; default value = $10.20/ft.

3-41. Oxidation Ditch Activated Sludge.

a. Design parameters for oxidation ditch activated sludge are listed below:

Parameter	Suggested Values
K	Reaction rate constant = 0.0007-0.002 ℓ/mg/hr
A	Fraction of BOD synthesized = 0.73
A'	Fraction of BOD oxidized for energy = 0.52
B	Endogenous respiration rate (sludge basis) = 0.075/day
B'	Endogenous respiration rate (oxygen basis) = 0.15/day
F	Nonbiodegradable fraction of VSS in influent = 0.40
F'	Degradable fraction of the MLVSS = 0.53
A_0	Fraction of BOD_5 synthesized to degradable solids = 0.56
F/M ratio	Food/microorganism ratio = 0.03-0.10

Additional parameters include:

Mixed liquor suspended solids = 4000-8000 mg/ℓ
Mixed liquor volatile solids = 2800-5600 mg/ℓ
Temperature correction coefficient = 1.0-1.03
Effluent BOD soluble = 10 mg/ℓ

b. Default data are given below:

```
CONSTANTS K=0.0012 A=0.73 AP=0.52 B=0.075 BP=0.15 F=0.4 FP=0.53 AO=0.56
F/M RATIO                               0.065      LB BOD/LB VSS
MIXED LIQUOR      SS=6000     VS=3750              MG/L
TEMPERATURE COEFFICIENT                 1.03
EFFLUENT BOD SOLUBLE                    10         MG/L
```

c. Oxidation ditch activated sludge unit process data cards are listed below:

OXIDATION DITCH ACTIVATED SLUDGE[a] MOD xx

CONSTANTS K = xx.x A = xx.x A' = xx.x B = xx.x B' = xx.x
F = xx.x F' = xx.x AO = xx.x

F/M RATIO xx.x LB BOD/LB VSS

MIXED LIQUOR SS = xx.x VS = xx.x MG/L

TEMPERATURE COEFFICIENT xx.x

EFFLUENT BOD SOLUBLE xx.x MG/L

ESTIMATE[b] COSTDS = xx.x COSTPS = xx.x

REPLACEMENT[c] RSDS = xx.x RSPS = xx.x RSST = xx.x YEARS

END

---

[a] User must also specify secondary clarification (oxidation ditch).

[b] COSTDS = Cost of standard 42-in.-diam by 20-ft rotor; default value = $15,340. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

[c] See Appendix F.

3-42. Plug Flow Activated Sludge.

a. Design parameters for Eckenfelder's approach are given below:

Parameter	Suggested Values
K	Reaction rate constant = 0.0007-0.002 ℓ/mg/hr
A	Fraction of BOD synthesized = 0.73
A'	Fraction of BOD oxidized for energy = 0.52
B	Endogenous respiration rate (sludge basis) = 0.075/day
B'	Endogenous respiration rate (oxygen basis) = 0.15/day
F	Nonbiodegradable fraction of VSS in influent = 0.40
F'	Degradable fraction of the MLVSS = 0.53
ALPHA	O_2 transfer in waste/O_2 transfer in water = 0.90
BETA	O_2 saturation in waste/O_2 saturation in water = 0.90
HPR	Horsepower per 1000 gal ≥ 0.10 hp/1000 gal
F/M ratio	Food/microorganism ratio = 0.2-0.4
STE	Standard transfer efficiency Mechanical aerators = 2.0-3.5 lb O_2/hp-hr High speed = 2.0 Slow speed = 3.5 Diffused aerator = 6.0-11.0% Coarse bubble = 6.0 Fine bubble = 11.0

Additional parameters include:

Mixed liquor suspended solids = 1500-3000 mg/ℓ
Mixed liquor volatile solids = 1050-2100 mg/ℓ
Temperature correction coefficient = 1.0-1.03
Effluent BOD soluble = 10 mg/ℓ

b. Default data are given below:

```
CONSTANTS K=0.00135 A=0.73 AP=0.52 B=0.075 BP=0.15 F=0.4 FP=0.53
F/M RATIO                          0.3         LB BOD/LB VSS
MIXED LIQUOR     SS=2500      VS=1750         MG/L
TEMPERATURE COEFFICIENT             1.03
EFFLUENT BOD SOLUBLE               10          MG/L
DIFFUSED AERATION ALPHA=0.9 BETA=0.9 AF=20.0 CM/TG STE=6   PERCENT
```

c. Plug flow activated sludge unit process data cards are listed below:

PLUG FLOW ACTIVATED SLUDGE[a] MOD xx

CONSTANTS K = xx.x A = xx.x A' = xx.x B = xx.x B' = xx.x
F = xx.x F' = xx.x

F/M RATIO xx.x LB BOD/LB VSS

MIXED LIQUOR SS = xx.x VS = xx.x MG/L

TEMPERATURE COEFFICIENT xx.x

EFFLUENT BOD SOLUBLE xx.x MG/L

MECHANICAL AERATION[b] ALPHA = xx.x BETA = xx.x
HPR = xx.x HPR/TG STE = xx.x LB O/HPR-HR

DIFFUSED AERATION[b] ALPHA = xx.x BETA = xx.x
AF[c] = xx.x CFM/TCUFT STE = xx.x PERCENT

ESTIMATE[d] SSXSA = xx.x COSTPD = xx.x COSTPH = xx.x
COSTPS = xx.x

REPLACEMENT[e] RSSA = xx.x RSPD = xx.x RSPH = xx.x
RSPS = xx.x RSST = xx.x YEARS

END

---

[a] User must also specify secondary clarification (activated sludge).

[b] Use mechanical or diffused, not both; default value = diffused. If mechanical aeration is specified, all data on mechanical card must be input.

[c] AF (minimum airflow) specifies a lower limit on airflow. Model will calculate actual airflow and compare it with input value. Higher value will be output. Input zero for AF to obtain calculated value only.

[d] SSXSA = Cost of standard slow-speed, pier-mounted 20-hp aerator; default value = $16,300. COSTPD = Cost of standard 12.0 scfm coarse-bubble diffuser; default value = $6.50. COSTPH = Cost of standard 550-scfm swing arm diffuser; default value = $5,000. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

[e] See Appendix F.

3-43. Postaeration.

a. Design parameters for postaeration are listed below:

Detention time = 5-15 min

Pressure correction factor = 1.0

Additional parameters include:

Parameter	Suggested Values
ALPHA	O_2 transfer in waste/O_2 transfer in water = 0.9
BETA	O_2 saturation in waste/O_2 saturation in water = 0.9
N	Water quality parameter for cascade aeration = 0.80
M	Weir geometry parameter Step = 1.30 Free = 1.00
STE	Standard transfer efficiency Mechanical aerators = 2.0-3.5 lb O_2/hp-hr High speed = 2.0 Slow speed = 3.5 Diffused aerator = 6.0-11.0% Coarse bubble = 6.0 Fine bubble = 11.0

b. Default data are given below:

```
POST AERATION                                          (POSTCO)
DIFFUSED AERATION ALPHA=0.9 BETA=0.9    STE=6   PERCENT
DETENTION TIME                         10            MIN
DISSOLVED OXYGEN       INITIAL=2.0      FINAL=5.0      MG/L
CORRECTION FOR PRESSURE                1.0
SUMMER TEMPERATURE                     27 DEG C
MINIMUM DISSOLVED OXYGEN               2.0 MG/L
```

c. Postaeration unit process data cards are listed below:

POSTAERATION MOD xx

DISSOLVED OXYGEN INFLUENT = xx.x EFFLUENT = xx.x MG/L

DETENTION TIME xx.x MINUTES

CORRECTION FOR PRESSURE xx.x

SUMMER TEMPERATURE xx.x DEG C

MINIMUM DISSOLVED OXYGEN xx.x MG/L

MECHANICAL AERATION[a] ALPHA = xx.x BETA = xx.x
STE = xx.x LB O/HP-HR

DIFFUSED AERATION[a] ALPHA = xx.x BETA = xx.x
STE = xx.x PERCENT

STEP CASCADE AERATION[a] N[b] = xx.x M[c] = xx.x

FREE CASCADE AERATION[a] N[b] = xx.x M[c] = xx.x

ESTIMATE[d] COSTSA = xx.x COSTPD = xx.x COSTPH = xx.x

REPLACEMENT[e] RSSA = xx.x RSPD = xx.x
RSPH = xx.x RSST = xx.x YEARS

END

---

[a] Use mechanical, diffused, step, or free aeration, but not more than one; default value = diffused.

[b] N is the water quality parameter for wastewater treatment plant effluent; default value = 0.80.

[c] M is the weir geometry parameter; default value = 1.0 for free aeration and 1.30 for step aeration.

[d] COSTSA = Cost of standard 50-hp high-speed floating aerator; default value = $13,960. COSTPD = Cost of standard 12-scfm coarse-bubble diffuser; default value = $6.50. COSTPH = Cost of standard 550-scfm swing arm diffuser; default value = $5,000.

[e] See Appendix F.

3-44. Primary Clarification.

a. Design parameters for primary clarification are listed below:

Sidewater depth = 7.0-12.0 ft
Underflow concentration of solids = 4.0-6.0%
Weir overflow rate = 10,000-15,000 gal/day/ft
Surface overflow rate (see Table 3-9)
Specific gravity of sludge (see Table 3-10)
Suspended solids removal (see Figure 3-3)
BOD removal (see Figure 3-4)

Table 3-9. Recommended Surface Loading Rates for Various Suspensions[a]

Suspension	Loading Rate, gpd/ft^2	
	Range	Peak Flow
Untreated wastewater	600 to 1200	1200
Alum floc[b]	360 to 600	600
Iron floc[b]	540 to 800	800
Lime floc[b]	540 to 1200	1200

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering; Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972 by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

[b] Mixed with the settleable suspended solids in the untreated wastewater and colloidal or other suspended solids swept out by the floc.

Table 3-10. Specific Gravity of Raw Sludge Produced from Various Types of Sewage[a]

Type of Sewerage System	Strength of Sewage	Specific Gravity
Sanitary	Weak	1.02
Sanitary	Medium	1.03
Combined	Medium	1.05
Combined	Strong	1.07

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering; Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972 by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

b. Default data are given below:

```
SURFACE OVERFLOW RATE                     1000      G/D/SQFT
SIDE WATER DEPTH                          9         FEET
SPECIFIC GRAVITY                          1.05
UNDERFLOW CONCENTRATION                   4         PERCENT
REMOVAL      SOLIDS=58      BOD=32        COD=40    TKN=5      PO=5   PERCENT
WEIR OVERFLOW RATE                        15000     G/D/FT
PRIMARY CLARIFICATION
CIRCULAR CLARIFIER                                  (PRIMCO)
```

c. Primary clarification unit process data cards are listed below:

PRIMARY CLARIFICATION MOD xx

SURFACE OVERFLOW RATE xx.x G/D/SQ FT

SIDEWATER DEPTH xx.x FT

SPECIFIC GRAVITY xx.x

UNDERFLOW CONCENTRATION xx.x PERCENT

REMOVAL SOLIDS[a] = xx.x BOD = xx.x COD = xx.x
TKN = xx.x PO = xx.x PERCENT

WEIR OVERFLOW RATE xx.x G/D/FT

RECTANGULAR CLARIFIER[b]

CIRCULAR CLARIFIER[b]

ESTIMATE[c] STANDARD MECHANISM COST = xx.x

REPLACEMENT[d] RSMS = xx.x RSST = xx.x YEARS

END

---

[a] Specify total removals.

[b] Use rectangular or circular clarifier, not both; default value = circular clarifier.

[c] Rectangular clarifier--cost of standard 20- by 120-ft clarifier mechanism; default value = $42,000. Circular clarifier--cost of standard 90-ft-diam clarifier mechanism; default value = $75,000.

[d] See Appendix F.

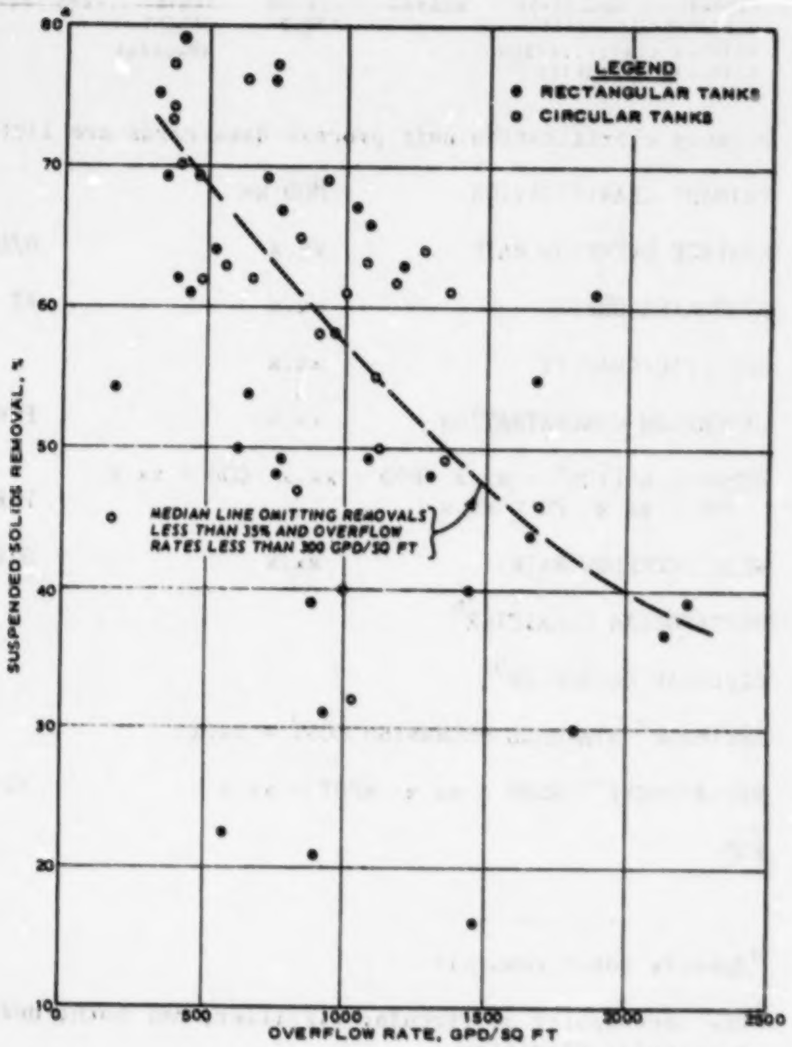

Figure 3-3. Suspended solids removal versus overflow rate for primary clarifiers (courtesy of American Society of Civil Engineers and the Water Pollution Control Federation 1977)

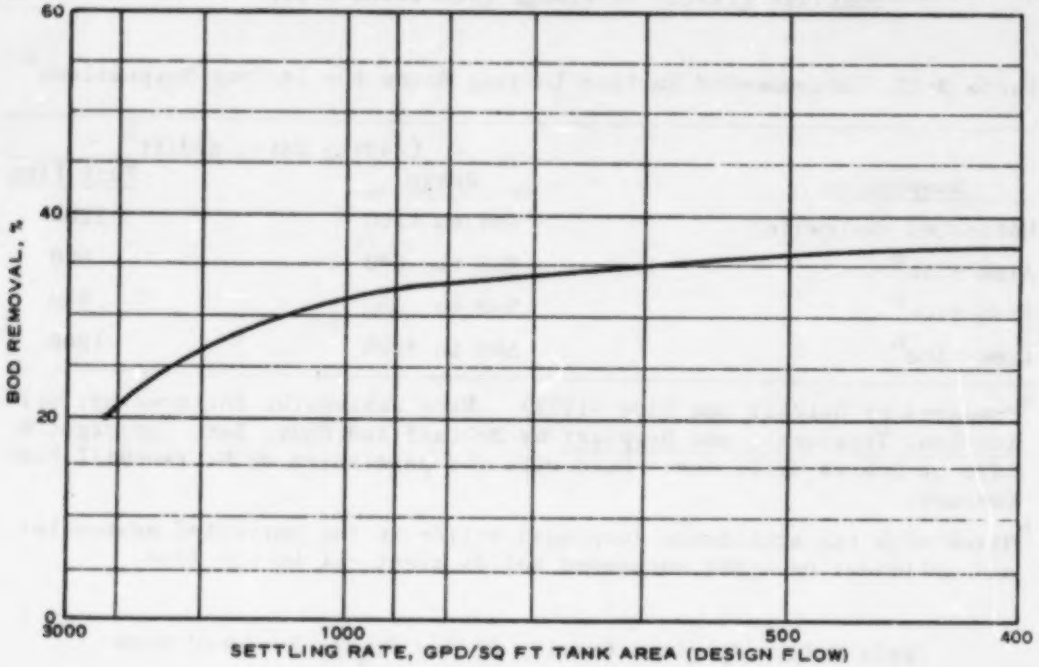

Figure 3-4. BOD removal rate in primary clarifier
(prepared by WES)

3-45. Primary Clarification (Two-Stage Lime Treatment).

a. Design parameters for primary clarification (two-stage lime treatment) are listed below:

Sidewater depth = 7.0-12.0 ft
Underflow concentration of solids = 4.0-6.0%
Weir overflow rate = 10,000-15,000 gal/day/ft
Surface overflow rate (see Table 3-11)
Specific gravity of sludge (see Table 3-12)

Table 3-11. Recommended Surface Loading Rates for Various Suspensions[a]

	Loading Rate, gpd/ft^2	
Suspension	Range	Peak Flow
Untreated wastewater	600 to 1200	1200
Alum floc[b]	360 to 600	600
Iron floc[b]	540 to 800	800
Lime floc[b]	540 to 1200	1200

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering; Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972 by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

[b] Mixed with the settleable suspended solids in the untreated wastewater and colloidal or other suspended solids swept out by the floc.

Table 3-12. Specific Gravity of Raw Sludge Produced from Various Types of Sewage[a]

Type of Sewerage System	Strength of Sewage	Specific Gravity
Sanitary	Weak	1.02
Sanitary	Medium	1.03
Combined	Medium	1.05
Combined	Strong	1.07

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering; Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972 by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

b. Default data are given below:

```
L PRIMARY CLARIFICATION (TWO STAGE LIME TREATMENT)    (LAIMCO)
SURFACE OVERFLOW RATE                   1000       G/SQFT/DAY
SIDE WATER DEPTH                        9          FEET
SPECIFIC GRAVITY                        1.03
UNDERFLOW CONCENTRATION                 6.0      PERCENT
REMOVAL  SS=80  BOD=65  COD=85  TKN=30  PO=80    PERCENT
WEIR OVERFLOW RATE                      15000      G/FT/DAY
```

c. Primary clarification (two-stage lime treatment) unit process data cards

L PRIMARY CLARIFICATION (TWO-STAGE LIME TREATMENT) MOD xx

SURFACE OVERFLOW RATE xx.x G/SQ FT/DAY

SIDEWATER DEPTH xx.x FT

SPECIFIC GRAVITY xx.x

UNDERFLOW CONCENTRATION xx.x PERCENT

REMOVAL[a] SS = xx.x BOD = xx.x COD = xx.x TKN = xx.x
PO = xx.x PERCENT

WEIR OVERFLOW RATE xx.x G/FT/DAY

RECTANGULAR CLARIFIER[b]

CIRCULAR CLARIFIER[b]

ESTIMATE[c] STANDARD MECHANISM COST = xx.x

REPLACEMENT[d] RSMS = xx.x RSST = xx.x YEARS

END

---

[a] Specify total removals.

[b] Use rectangular or circular clarifier, not both; default value = circular clarifier.

[c] Rectangular clarifier--cost of standard 20- by 120-ft clarifier mechanism; default value = $42,000. Circular clarifier--cost of 90-ft-diam clarifier mechanism; default value = $75,000.

[d] See Appendix F.

3-46. <u>Pumping</u>.

a. Design parameters for pumping are listed below:

Flow should be specified as a percent of the average flow.

b. Default data are given below:

```
FLOW                      100.00 PERCENT
DAYS PER WEEK               7.00 DAYS
HOURS PER DAY              24.00 HOURS
```

c. Pumping unit process data cards are listed below:

PUMP[a] MOD xx.x

FLOW xx.x PERCENT

DAYS PER WEEK xx.x DAYS

HOURS PER DAY xx.x HOURS

ESTIMATE[b] COSTPS = xx.x

REPLACEMENT[c] RSPS = xx.x RSST = xx.x YEARS

END

---

[a] This process is included automatically by some treatment processes. These processes may be identified by the presence of COSTPS on the ESTIMATE card of the unit process input data cards.

[b] COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

[c] See Appendix F.

3-47. Pure Oxygen Activated Sludge.

a. Design parameters for Eckenfelder's approach are listed below:

Parameter	Suggested Values
F'	Degradable fraction of the MLVSS = 0.53
ALPHA	O_2 transfer in waste/O_2 transfer in water = 0.90
BETA	O_2 saturation in waste/O_2 saturation in water = 0.90
HPR	Horsepower per 1000 gal $\geq$ 0.10 hp/1000 gal
F/M ratio	Food microorganism ratio = 0.25-1.0
STE	Standard transfer efficiency Mechanical aerators = 2.0-3.5 lb O_2/hp-hr High speed = 2.0 Slow speed = 3.5

Additional parameters include:

Temperature correction coefficient = 1.0-1.03
Effluent BOD soluble = 10 mg/ℓ

b. Default data are given below:

```
CONSTANTS  FP=0.53
MIXED LIQUOR  SS=7000     VS=5500
F/M RATIO                          0.625     LB BOD/LB VSS
EFFLUENT BOD SOLUBLE               10        MG/L
MECHANICAL AERATION ALPHA=0.9 BETA=0.9 HPR=0.10 HPR/TG STE=3.5 LB O/HPR/HR
```

c. Pure oxygen activated sludge unit process data cards are listed below:

PURE OXYGEN ACTIVATED SLUDGE[a] MOD xx

CONSTANTS F' = xx.x

F/M RATIO xx.x LB BOD/LB VSS

MIXED LIQUOR MLSS = xx.x MLVSS = xx.x MG/L

EFFLUENT BOD SOLUBLE xx.x MG/L

MECHANICAL AERATION ALPHA = xx.x BETA = xx.x
HPR = xx.x HPR/TG STE = xx.x LB O/HP-HR

ESTIMATE[b] SSXSA = xx.x COSTSP = xx.x COSTSCR = xx.x
COSTPS = xx.x

REPLACEMENT[c] RSSA = xx.x RSSP = xx.x RSCR = xx.x
RSPS = xx.x RSST = xx.x YEARS

END

---

[a] User must also specify secondary clarification (pure oxygen).

[b] SSXSA = Cost of standard slow-speed, pier-mounted 20-hp aerator; default value = $16,300. COSTSP = Cost of standard 10-ton pressure swing adsorption (PSA) oxygen generation unit; default value = $800,000. COSTSCR = Cost of standard 50-ton cryogenic oxygen generation unit; default value = $1,900,000. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

[c] See Appendix F.

3-48. Rapid Infiltration Land Treatment.

a. Design parameters for rapid infiltration land treatment are listed below:

Application rate = 4.0-150.0 in./wk

Buffer zone (site dependent) = 0.0-500.0 ft

Fraction of nitrogen loading denitrified = 30.0-60.0% (percent of total applied N)

Ammonia volatilization = 0.0% (percent of total applied N)

b. Default data are given below:

```
APPLICATION RATE                     35.0   IN/WEEK
PRECIPITATION RATE                    0.8   IN/WEEK
EVAPOTRANSPIRATION RATE               0.4   IN/WEEK
WASTEWATER GENERATION PERIOD        365.0   DAYS/YR
NO RECOVERY SYSTEM
BUFFER ZONE                           0.0   FEET
MONITORING WELLS                  9 WELLS AT 10 FT/WELL
FENCING                              2.75   $/FT
FRACTION DENITRIFIED                 45.0   PERCENT OF APPLIED N
AMMONIA VOLATILIZATION                0.0   PERCENT OF APPLIED N
```

c. Rapid infiltration land treatment unit process data cards are listed below:

```
RAPID INFILTRATION LAND TREATMENT   MOD  xx
APPLICATION RATE                                  xx.x      IN/WK
PRECIPITATION RATE                                xx.x      IN/WK
EVAPOTRANSPIRATION RATE                           xx.x      IN/WK
WASTEWATER GENERATION PERIOD                      xx.x      DAYS/YR
NO RECOVERY SYSTEM[a]
UNDERDRAIN RECOVERY SYSTEM[a]
RECOVERY WELLS SYSTEM[a,b]  NW = xx.x  WDIA = xx.x  IN
  DW = xx.x  FT
BUFFER WIDTH                                      xx.x      FT
MONITORING WELLS  NO = xx.x  DEPTH/WELL = xx.x              FT
FENCING[c,d]   CSFN = xx.x $/FT   RSFN = xx.x               YEARS
FRACTION DENITRIFIED                              xx.x      PERCENT
AMMONIA VOLATILIZATION                            xx.x      PERCENT
ESTIMATE[e] SP = xx.x  BV = xx.x  PP = xx.x CP = xx.x WW = xx.x
  PS = xx.x
REPLACEMENT[d] RSSP = xx.x RSBV = xx.x RSPP = xx.x RSCP = xx.x
  RSMW = xx.x RSRW = xx.x RSPS = xx.x RSST = xx.x           YEARS
END
```

---

[a] Use recovery wells, underdrains, or no recovery system, but not more than one; default value = no recovery system.

[b] NW = Number of recovery wells. WDIA = Diameter of recovery wells. DW = Depth of recovery wells.

[c] CSFN = Cost of fencing; RSFN = Service life of fence

[d] See Appendix F.

[e] SP = Cost of 12-in. welded steel pipe, in place; default value = $12.80/ft. BV = Cost of 12-in. butterfly valve; default value = $952.10. PP = Cost of 6-in. perforated polyvinyl chloride pipe; default value = $6.94/ft. CP = Cost of 24-in. concrete Class III pipe; default value = $10.20/ft. WW = Cost of 4-in. water well; default value = $8.00/ft. RW = Cost of 4-in. recovery well; default value = $8.00/ft. PS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

3-49. <u>Recarbonation</u>.

a. Design parameters for recarbonation are listed below:

Detention time = 15.0-30.0 min

Alkalinity of hydroxide (determine from waste characterization study) = 50.0 mg/ℓ

Alkalinity of carbonate (determine from waste characterization study) = 150.0 mg/ℓ

b. Default data are given below:

```
DETENTION TIME                         15         MIN
ALKALINITY      HYDROXIDE=50      CARBONATE=150     MG/L
```

c. Recarbonation unit process data cards are listed below:

RECARBONATION[a] MOD xx

DETENTION TIME xx.x MIN

ALKALINITY HYDROXIDE = xx.x CARBONATE = xx.x MG/L

REPLACEMENT[b] RSST = xx.x YEARS

END

---

[a] This unit process is parametrically costed.

[b] See Appendix F.

3-50. <u>First Stage Recarbonation</u>.

a. Design parameters for first stage recarbonation are listed below:

Detention time = 15.0-30.0 min

Alkalinity of hydroxide (determine from waste characterization study) = 50.0 mg/ℓ

Alkalinity of carbonate (determine from waste characterization study) = 150.0 mg/ℓ

b. Default data are given below:

```
DETENTION TIME                         15          MIN
ALKALINITY      HYDROXIDE=50      CARBONATE=150    MG/L
```

c. First stage recarbonation unit process data cards are listed below:

FIRST STAGE RECARBONATION[a]   MOD xx

DETENTION TIME   xx.x   MIN

ALKALINITY HYDROXIDE = xx.x CARBONATE = xx.x   MG/L

REPLACEMENT[b]   RSST = xx.x   YEARS

END

---

[a] This unit process is parametrically costed.

[b] See Appendix F.

3-51. Second Stage Recarbonation.

a. Design parameters for second stage recarbonation are listed below:

Detention time = 15.0-30.0 min

Alkalinity of hydroxide (determine from waste characterization study) = 50.0 mg/ℓ

Alkalinity of carbonate (determine from waste characterization study) = 150.0 mg/ℓ

b. Default data are given below:

```
DETENTION TIME                      15          MIN
ALKALINITY      HYDROXIDE=50      CARBONATE=150      MG/L
```

c. Second stage recarbonation unit process data cards are listed below:

SECOND STAGE RECARBONATION[a] MOD xx

DETENTION TIME xx.x MIN

ALKALINITY HYDROXIDE = xx.x CARBONATE = xx.x MG/L

REPLACEMENT[b] RSST = xx.x YEARS

END

---

[a] This unit process is parametrically costed.

[b] See Appendix F.

3-52. Raw Sewage Pumping.

a. Design parameters for raw sewage pumping are listed below:

Static head is the vertical distance between the invert of the incoming sewer and the maximum water level in the next unit process.

Number of pumps - if the number of pumps is not specified, the following will be used.

Number of Pumps	Peak Flow
2	less than 1 mgd
3	1 to 50 mgd
4	50 to 150 mgd
5	greater than 150 mgd

Number of pumps should include one standby pump.

b. Default data are given below:

```
DEPTH TO INFLUENT SEWER          15.0 FEET
STATIC HEAD                      40.0 FEET
CONSTANT SPEED PUMPS
```

c. Raw sewage pumping unit process data cards are listed below:

RAW SEWAGE PUMPING MOD xx

DEPTH TO INFLUENT SEWER xx.x FT

STATIC HEAD xx.x FT

NUMBER OF PUMPS xx.x

PEAK FLOW xx.x MGD

VARIABLE SPEED[a]

CONSTANT SPEED[a]

ESTIMATE[b] COSTPS = xx.x COSTMS = xx.x COSTVS = xx.x

REPLACEMENT[c] RSPS = xx.x RSMS = xx.x RSVS = xx.x
RSST = xx.x YEARS

END

---

[a] Use constant speed or variable speed, not both. If variable speed pumps are selected, the first two will be constant speed with the remainder being variable speed. If constant speed pumps are selected, all pumps will be constant speed; default value = constant speed.

[b] COSTPS = Cost of standard 16-in. pump; default value = $13,630. COSTMS = Cost of standard size 100-hp, 1,200-rpm synchronous motor; default value = $2,350. COSTVS = Cost of a variable frequency drive module for a 20-hp motor; default value = $11,500.

[c] See Appendix F.

3-53. Rotating Biological Contactor.

a. Design parameters for rotating biological contactor are listed below:

Contactor underflow solids = 125.0 mg/ℓ

b. Default data are given below:

```
DESIRED EFFLUENT BOD=25.0 BODS=10.0 SS=25.0 MG/L
CONTACTOR UNDERFLOW SOLIDS          125.0 MG/L
```

c. Rotating biological contactor unit process data cards are listed below:

RBC[a] MOD xx

CONTACTOR UNDERFLOW SOLIDS xx.x MG/L

DESIRED EFFLUENT BOD = xx.x BODS = xx.x SS = xx.x

ESTIMATE[b] COSTES = xx.x COSTPS = xx.x

REPLACEMENT[c] RSES = xx.x RSPS = xx.x RSST = xx.x YEARS

END

---

[a] User should also specify secondary clarification (rotating biological contactor).

[b] COSTES = Cost of rotating biological contactor equipment including media, shaft, and fiberglas cover. Standard size is a shaft with media surface area of 100,000 sq ft; default value = $30,500. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

[c] See Appendix F.

3-54. Screening.

a. Design parameters for screening are listed below:

Bar shape factor:
Sharp-edged rectangular bars = 2.42
Rectangular bars with semicircular upstream face = 1.83
Circular bars = 1.79
Rectangular bars with both ends semicircular = 1.67
Rectangular bars with semicircular upstream faces and tapered symmetrical circular downstream faces = 0.76

Bar screen width (see Table 3-13)

Bar screen spacing (see Table 3-13)

Bar screen slope (see Table 3-13)

Approach velocities (see Table 3-13)

Table 3-13. General Characteristics of Bar Screens[a]

Item	Hand Cleaned	Mechanically Cleaned
Bar screen size		
Width, in.	1/4 to 5/8	1/4 to 5/8
Depth, in.	1 to 3	1 to 3
Spacing, in.	1 to 2	5/8 to 3
Slope from vertical, deg	30 to 45	0 to 30
Approach velocity, fps	1 to 2	2 to 3
Allowable head loss, in.	6	6

[a] Prepared by WES.

b. Default data are given below:

```
MECHANICALLY CLEANED                DEPTH=1         FEET
BARS  WIDTH=0.25 IN  SPACE=1.5 IN  SLOPE=30 DEG  SHAPE FACT=2.42
VELOCITIES  APPROACH=2.5  MAX=3.0  AVE=2.5          FPS
```

c. Screening unit process data cards are listed below:

SCREENING[a] MOD xx

MECHANICALLY CLEANED[b] DEPTH = xx.x FT

MANUALLY CLEANED[b] DEPTH = xx.x FT

BARS WIDTH = xx.x IN SPACE = xx.x IN SLOPE = xx.x DEG
SHAPE FACTOR = xx.x

VELOCITIES APPROACH = xx.x MAX = xx.x AVG = xx.x FT/SEC

END

---

[a] This process is part of preliminary treatment and is parametrically costed.

[b] Use mechanically cleaned or manually cleaned, not both; default value = mechanically cleaned.

[c] Replacement life is included with grit removal unit process.

3-55. Secondary Clarification (Activated Sludge).

a. Design parameters for secondary clarification (activated sludge) are listed below:

Solids loading rate = 12.0-30.0 lb/sq ft/day

Surface overflow rate (small plants ≤ 1.0 mgd)
= <600 gal/sq ft/day

Surface overflow rate (large plants ≥ 1.0 mgd)
= <800 gal/sq ft/day

Underflow concentration = 0.8-1.2%

Weir overflow rate = 10,000-15,000 gal/ft/day

Sidewater depth = 7.0-12.0 ft

Specific gravity of sludge (see Table 3-14)

Table 3-14. Specific Gravity of Raw Sludge Produced from Various Types of Sewage[a]

Type of Sewerage System	Strength of Sewage	Specific Gravity
Sanitary	Weak	1.02
Sanitary	Medium	1.03
Combined	Medium	1.05
Combined	Strong	1.07

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering; Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972 by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

b. Default data are given below:

```
A SECONDARY CLARIFICATION (ACTIVATED SLUDGE)           (SECOCO)
CIRCULAR
SOLID LOADING RATE (MAXIMUM)          20        LB/SQFT/DAY
SURFACE OVERFLOW RATE                 500       G/SQFT/DAY
SPECIFIC GRAVITY OF SLUDGE            1.03
UNDERFLOW CONCENTRATION               1.0       PERCENT
WEIR OVERFLOW RATE (MAXIMUM)          15000     G/D/FT
SIDE WATER DEPTH                      9         FEET
EFFLUENT SUSPENDED SOLIDS             20        MG/L
```

c. Secondary clarification (activated sludge) unit process data cards are listed below:

A SECONDARY CLARIFICATION (ACTIVATED SLUDGE)	MOD xx	
SOLID LOADING RATE (MAXIMUM)	xx.x	LB/SQ FT/DAY
SURFACE OVERFLOW RATE	xx.x	G/SQ FT/DAY
SPECIFIC GRAVITY OF SLUDGE	xx.x	
UNDERFLOW CONCENTRATION	xx.x	PERCENT
WEIR OVERFLOW RATE	xx.x	G/FT/DAY
SIDEWATER DEPTH	xx.x	FT
EFFLUENT SUSPENDED SOLIDS	xx.x	MG/L
RECTANGULAR CLARIFIER[a]		
CIRCULAR CLARIFIER[a]		
ESTIMATE[b] STANDARD MECHANISM COST = xx.x		
REPLACEMENT[c] RSMS = xx.x RSST = xx.x		YEARS
END		

---

[a] Use rectangular or circular clarifier, not both; default value = circular clarifier.

[b] Rectangular clarifier--cost of standard 20- by 120-ft clarifier mechanism; default value = $42,000. Circular clarifier--cost of standard 90-ft-diam clarifier mechanism; default value = $75,000.

[c] See Appendix F.

3-56. Secondary Clarification (Denitrification).

a. Design parameters for secondary clarification (denitrification) are listed below:

Solids loading rate = 12.0-30.0 lb/sq ft/day

Surface overflow rate $\leq$ 600 gal/sq ft/day

Underflow concentration = 0.8-1.2%

Weir overflow rate = 10,000-15,000 gal/ft/day

Sidewater depth = 7.0-12.0 ft

Degradable fraction of the MLVSS (F') = 0.53

b. Default data are given below:

```
D SECONDARY CLARIFICATION    (SUSPENDED GROWTH DENITRIFICATION)
CIRCULAR
SOLID LOADING RATE (MAXIMUM)       20       LB/SQFT/DAY
SURFACE OVERFLOW RATE              600     G/SQFT/DAY
SPECIFIC GRAVITY OF SLUDGE         1.03
UNDERFLOW CONCENTRATION            1.0      PERCENT
WEIR OVERFLOW RATE (MAXIMUM)       15000    G/D/FT
SIDE WATER DEPTH                   9        FEET
EFFLUENT SUSPENDED SOLIDS          20       MG/L
CONSTANT          FP=0.53
CIRCULAR CLARIFIER
```

c. Secondary clarification (denitrification) unit process data cards are listed below:

D SECONDARY CLARIFICATION (DENITRIFICATION)[a]	MOD xx	
SOLID LOADING RATE (MAXIMUM)	xx.x	LB/SQ FT/DAY
SURFACE OVERFLOW RATE	xx.x	G/SQ FT/DAY
CONSTANT FP = xx.x		FRACTION
SPECIFIC GRAVITY OF SLUDGE	xx.x	
UNDERFLOW CONCENTRATION	xx.x	PERCENT
WEIR OVERFLOW RATE (MAXIMUM)	xx.x	G/FT/DAY
SIDEWATER DEPTH	xx.x	FT
EFFLUENT SUSPENDED SOLIDS	xx.x	MG/L
RECTANGULAR CLARIFIER[b]		
CIRCULAR CLARIFIER[b]		
ESTIMATE[c] STANDARD MECHANISM COST = xx.x		
REPLACEMENT[d] RSMS = xx.x RSST = xx.x		YEARS
END		

---

[a] This process is used with the suspended growth denitrification process.

[b] Use rectangular or circular clarifier, not both; default value = circular clarifier.

[c] Rectangular clarifier--cost of standard 20- by 120-ft clarifier mechanism; default value = $42,000. Circular clarifier--cost of standard 90-ft-diam clarifier mechanism; default value = $75,000.

[d] See Appendix F.

3-57. Secondary Clarification (Nitrification).

a. Design parameters for secondary clarification (nitrification) are listed below:

Solids loading rate = 12.0-30.0 lb/sq ft/day

Surface overflow rate ≤ 600 gal/sq ft/day

Underflow concentration = 0.8-1.2%

Weir overflow rate = 10,000-15,000 gal/ft/day

Sidewater depth = 7.0-12.0 ft

Degradable fraction of the MLVSS (F') = 0.53

b. Default data are given below:

```
N SECONDARY CLARIFICATION  (SUSPENDED GROWTH NITRIFICATION)
CIRCULAR
SOLID LOADING RATE (MAXIMUM)       20        LB/SQFT/DAY
SURFACE OVERFLOW RATE              600       G/SQFT/DAY
SPECIFIC GRAVITY OF SLUDGE         1.03
UNDERFLOW CONCENTRATION            1.0       PERCENT
WEIR OVERFLOW RATE (MAXIMUM)       15000     G/D/FT
SIDE WATER DEPTH                   9         FEET
EFFLUENT SUSPENDED SOLIDS          20        MG/L
CONSTANT        FP=0.53
CIRCULAR CLARIFIER
END
```

c. Secondary clarification (nitrification) unit process data cards are listed below:

N SECONDARY CLARIFICATION (NITRIFICATION)[a]	MOD	xx
SOLID LOADING RATE (MAXIMUM)	xx.x	LB/SQ FT/DAY
SURFACE OVERFLOW RATE	xx.x	G/SQ FT/DAY
CONSTANT FP = xx.x		FRACTION
SPECIFIC GRAVITY OF SLUDGE	xx.x	
UNDERFLOW CONCENTRATION	xx.x	PERCENT
WEIR OVERFLOW RATE (MAXIMUM)	xx.x	G/FT/DAY
SIDEWATER DEPTH	xx.x	FT
EFFLUENT SUSPENDED SOLIDS	xx.x	MG/L
RECTANGULAR CLARIFIER[b]		
CIRCULAR CLARIFIER[b]		
ESTIMATE[c] STANDARD MECHANISM COST = xx.x		
REPLACEMENT[d] RSMS = xx.x RSST = xx.x		YEARS
END		

---

[a] This process is used with the suspended growth nitrification process.

[b] Use rectangular or circular clarifier, not both; default value = circular clarifier.

[c] Rectangular clarifier--cost of standard 20- by 120-ft clarifier mechanism; default value = $42,000. Circular clarifier--cost of standard 90-ft-diam clarifier mechanism; default value = $75,000.

[d] See Appendix F.

3-58. Secondary Clarification (Oxidation Ditch).

a. Design parameters for secondary clarification (oxidation ditch) are listed below:

Solids loading rate = 12.0-30.0 lb/sq ft/day

Surface overflow rate (small plants ≤ 1.0 mgd)
≤ 600 gal/sq ft/day

Surface overflow rate (large plants ≥ 1.0 mgd)
≤ 800 gal/sq ft/day

Underflow concentration = 0.8-1.2%

Weir overflow rate = 10,000-15,000 gal/ft/day

Sidewater depth = 7.0-12.0 ft

Specific gravity of sludge (see Table 3-15)

Table 3-15. Specific Gravity of Raw Sludge Produced from Various Types of Sewage[a]

Type of Sewerage System	Strength of Sewage	Specific Gravity
Sanitary	Weak	1.02
Sanitary	Medium	1.03
Combined	Medium	1.05
Combined	Strong	1.07

[a] Prepared by Metcalf and Eddy (1972). From *Wastewater Engineering; Collection, Treatment, and Disposal* by Metcalf and Eddy, Inc. Copyright © 1972 by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

b. Default data are given below:

```
O SECONDARY CLARIFICATION  (OXIDATION DITCH)
CIRCULAR
SOLID LOADING RATE (MAXIMUM)        20       LB/SQFT/DAY
SURFACE OVERFLOW RATE               500      G/SQFT/DAY
SPECIFIC GRAVITY OF SLUDGE          1.03
UNDERFLOW CONCENTRATION             1.0      PERCENT
WEIR OVERFLOW RATE (MAXIMUM)        15000    G/D/FT
SIDE WATER DEPTH                    9        FEET
EFFLUENT SUSPENDED SOLIDS           20       MG/L
```

c. Secondary clarification (oxidation ditch) unit process data cards are listed below:

0 SECONDARY CLARIFICATION (OXIDATION DITCH)[a]	MOD xx	
SOLID LOADING RATE (MAXIMUM)	xx.x	LB/SQ FT/DAY
SURFACE OVERFLOW RATE	xx.x	G/SQ FT/DAY
SPECIFIC GRAVITY OF SLUDGE	xx.x	
UNDERFLOW CONCENTRATION	xx.x	PERCENT
WEIR OVERFLOW RATE	xx.x	G/FT/DAY
SIDEWATER DEPTH	xx.x	FT
EFFLUENT SUSPENDED SOLIDS	xx.x	MG/L
RECTANGULAR CLARIFIER[b]		
CIRCULAR CLARIFIER[b]		
ESTIMATE[c] STANDARD MECHANISM COST = xx.x		
REPLACEMENT[d] RSMS = xx.x RSST = xx.x		YEARS
END		

---

[a] This process is used with the oxidation ditch process.

[b] Use rectangular or circular clarifier, not both; default value = circular clarifier.

[c] Rectangular clarifier--cost of standard 20- by 120-ft clarifier mechanism; default value = $42,000. Circular clarifier--cost of standard 90-ft-diam clarifier mechanism; default value = $75,000.

[d] See Appendix F.

3-59. Secondary Clarification (Pure Oxygen).

a. Design parameters for secondary clarification (pure oxygen) are listed below:

Solids loading rate = 12.0-30.0 lb/sq ft/day

Surface overflow rate (small plants ≤ 1.0 mgd)
≤ 600 gal/sq ft/day

Surface overflow rate (large plants ≥ 1.0 mgd)
≤ 800 gal/sq ft/day

Underflow concentration = 0.8-1.2%

Weir overflow rate = 10,000-15,000 gal/ft/day

Sidewater depth = 7.0-12.0 ft

Specific gravity of sludge (see Table 3-16)

Table 3-16. Specific Gravity of Raw Sludge Produced from Various Types of Sewage[a]

Type of Sewerage System	Strength of Sewage	Specific Gravity
Sanitary	Weak	1.02
Sanitary	Medium	1.03
Combined	Medium	1.05
Combined	Strong	1.07

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering; Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972 by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

b. Default data are given below:

```
P SECONDARY CLARIFICATION  (PURE OXYGEN ACTIVATED SLUDGE)
CIRCULAR
SOLID LOADING RATE (MAXIMUM)        20        LB/SQFT/DAY
SURFACE OVERFLOW RATE               500       G/SQFT/DAY
SPECIFIC GRAVITY OF SLUDGE          1.03
UNDERFLOW CONCENTRATION             1.0       PERCENT
WEIR OVERFLOW RATE (MAXIMUM)        15000     G/D/FT
SIDE WATER DEPTH                    9         FEET
EFFLUENT SUSPENDED SOLIDS           20        MG/L
```

c. Secondary clarification (pure oxygen) unit process data cards are listed below:

P SECONDARY CLARIFICATION (PURE OXYGEN)[a]	MOD xx	
SOLID LOADING RATE (MAXIMUM)	xx.x	LB/SQ FT/DAY
SURFACE OVERFLOW RATE	xx.x	G/SQ FT/DAY
SPECIFIC GRAVITY OF SLUDGE	xx.x	
UNDERFLOW CONCENTRATION	xx.x	PERCENT
WEIR OVERFLOW RATE	xx.x	G/FT/DAY
SIDEWATER DEPTH	xx.x	FT
EFFLUENT SUSPENDED SOLIDS	xx.x	MG/L
RECTANGULAR CLARIFIER[b]		
CIRCULAR CLARIFIER[b]		
ESTIMATE[c] STANDARD MECHANISM COST = xx.x		
REPLACEMENT[d] RSMS = xx.x RSST = xx.x		YEARS
END		

---

[a] This process is used with the pure oxygen process.

[b] Use rectangular or circular clarifier, not both; default value = circular clarifier.

[c] Rectangular clarifier--cost of standard 20- by 120-ft clarifier mechanism; default value = $42,000. Circular clarifier--cost of standard 90-ft-diam clarifier mechanism; default value = $75,000.

[d] See Appendix F.

3-60. Secondary Clarification (Rotating Biological Contactor).

a. Design parameters for secondary clarification (rotating biological contactor) are listed below:

Solids loading rate = 12.0-30.0 lb/sq ft/day

Surface overflow rate (small plants ≤ 1.0 mgd)
≤ 600 gal/sq ft/day

Surface overflow rate (large plants ≥ 1.0 mgd)
≤ 800 gal/sq ft/day

Underflow concentration = 0.8-1.2%

Weir overflow rate = 10,000-15,000 gal/ft/day

Sidewater depth = 7.0-12.0 ft

Specific gravity of sludge (see Table 3-17)

Table 3-17. Specific Gravity of Raw Sludge Produced from Various Types of Sewage[a]

Type of Sewerage System	Strength of Sewage	Specific Gravity
Sanitary	Weak	1.02
Sanitary	Medium	1.03
Combined	Medium	1.05
Combined	Strong	1.07

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering; Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972 by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

b. Default data are given below:

```
R SECONDARY CLARIFICATION  (RBC)
CIRCULAR
SOLID LOADING RATE (MAXIMUM)      20       LB/SQFT/DAY
SURFACE OVERFLOW RATE             500      G/SQFT/DAY
SPECIFIC GRAVITY OF SLUDGE        1.03
UNDERFLOW CONCENTRATION           1.0      PERCENT
WEIR OVERFLOW RATE (MAXIMUM)      15000    G/D/FT
SIDE WATER DEPTH                  9        FEET
EFFLUENT SUSPENDED SOLIDS         20       MG/L
```

c. Secondary clarification (rotating biological contactor) unit process data cards are listed below:

R SECONDARY CLARIFICATION (RBC)[a] MOD xx		
SOLID LOADING RATE (MAXIMUM)	xx.x	LB/SQ FT/DAY
SURFACE OVERFLOW RATE	xx.x	G/SQ FT/DAY
SPECIFIC GRAVITY OF SLUDGE	xx.x	
UNDERFLOW CONCENTRATION	xx.x	PERCENT
WEIR OVERFLOW RATE	xx.x	G/FT/DAY
SIDEWATER DEPTH	xx.x	FT
EFFLUENT SUSPENDED SOLIDS	xx.x	MG/L
RECTANGULAR CLARIFIER[b]		
CIRCULAR CLARIFIER[b]		
ESTIMATE[c] STANDARD MECHANISM COST = xx.x		
REPLACEMENT[d] RSMS = xx.x RSST = xx.x		YEARS
END		

---

[a] This process should be used with the rotating biological contactor unit process.

[b] Use rectangular or circular clarifier, not both; default value = circular clarifier.

[c] Rectangular clarifier--cost of standard 20- by 120-ft clarifier mechanism; default value = $42,000. Circular clarifier--cost of standard 90-ft-diam clarifier mechanism; default value = $75,000.

[d] See Appendix F.

3-61. Secondary Clarification (Trickling Filters).

a. Design parameters for secondary clarification (trickling filters) are listed below:

Solids loading rate = 12.0-30.0 lb/sq ft/day

Surface overflow rate (small plants $\leq$ 1.0 mgd) $\leq$ 600 gal/sq ft/day

Surface overflow rate (large plants $\geq$ 1.0 mgd) $\leq$ 800 gal/sq ft/day

Underflow concentration = 2.0-4.0%

Weir overflow rate = 10,000-15,000 gal/ft/day

Sidewater depth = 7.0-12.0 ft

Filter underflow solids = 1000-2500 mg/ℓ

Specific gravity of sludge (see Table 3-18)

Table 3-18. Specific Gravity of Raw Sludge Produced from Various Types of Sewage[a]

Type of Sewerage System	Strength of Sewage	Specific Gravity
Sanitary	Weak	1.02
Sanitary	Medium	1.03
Combined	Medium	1.05
Combined	Strong	1.07

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering; Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972 by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

b. Default data are given below:

```
CIRCULAR
SOLID LOADING RATE                   20      LB/SQFT/DAY
SURFACE OVERFLOW RATE  (MAXIMUM)     800     G/SQFT/DAY
SPECIFIC GRAVITY OF SLUDGE           1.03
UNDERFLOW CONCENTRATION              3.0     PERCENT
WEIR OVERFLOW RATE (MAXIMUM)         15000   G/D/FT
SIDE WATER DEPTH                     9       FEET
EFFLUENT SUSPENDED SOLIDS            20      MG/L
FILTER UNDERFLOW SOLIDS              1600    MG/L
```

c. Secondary clarification (trickling filters) unit process data cards are listed below:

T SECONDARY CLARIFICATION (TRICKLING FILTERS)[a]	MOD xx	
SOLID LOADING RATE (MAXIMUM)	xx.x	LB/SQ FT/DAY
SURFACE OVERFLOW RATE	xx.x	G/SQ FT/DAY
SPECIFIC GRAVITY OF SLUDGE	xx.x	
UNDERFLOW CONCENTRATION	xx.x	PERCENT
WEIR OVERFLOW RATE (MAXIMUM)	xx.x	G/FT/DAY
SIDEWATER DEPTH	xx.x	FT
EFFLUENT SUSPENDED SOLIDS	xx.x	MG/L
FILTER UNDERFLOW SOLIDS	xx.x	MG/L
RECTANGULAR CLARIFIER[b]		
CIRCULAR CLARIFIER[b]		

ESTIMATE[c] STANDARD MECHANISM COST = xx.x

REPLACEMENT[d] RSMS = xx.x RSST = xx.x

END

---

[a] This process is part of the trickling filtration process.

[b] Use rectangular or circular clarifier, not both; default value = circular clarifier.

[c] Rectangular clarifier--cost of standard 20- by 120-ft clarifier mechanism; default value = $42,000. Circular clarifier--cost of standard 90-ft-diam clarifier mechanism; default value = $75,000.

[d] See Appendix F.

3-62. Secondary Clarification (User-Specified).

a. Design parameters for secondary clarification (user-specified) are listed below:

Solids loading rate = 12.0-30.0 lb/sq ft/day

Surface overflow rate (small plants ≤ 1.0 mgd) = <600 gal/sq ft/day

Surface overflow rate (large plants ≥ 1.0 mgd) = <800 gal/sq ft/day

Underflow concentration = 0.8-1.2%

Weir overflow rate = 10,000-15,000 gal/ft/day

Sidewater depth = 7.0-12.0 ft

Specific gravity of sludge (see Table 3-19)

Table 3-19. Specific Gravity of Raw Sludge Produced from Various Types of Sewage[a]

Type of Sewerage System	Strength of Sewage	Specific Gravity
Sanitary	Weak	1.02
Sanitary	Medium	1.03
Combined	Medium	1.05
Combined	Strong	1.07

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering; Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972 by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

b. Default data are given below:

```
CIRCULAR
SOLID LOADING RATE (MAXIMUM)       20      LB/SQFT/DAY
SURFACE OVERFLOW RATE              800     G/SQFT/DAY
SPECIFIC GRAVITY OF SLUDGE         1.03
UNDERFLOW CONCENTRATION            3.0     PERCENT
WEIR OVERFLOW RATE (MAXIMUM)       15000   G/D/FT
SIDE WATER DEPTH                   9       FEET
EFFLUENT SUSPENDED SOLIDS          20      MG/L
FILTER UNDERFLOW SOLIDS            1000    MG/L
```

c. Secondary clarification (user-specified) unit process data cards are listed below:

```
CLARIFIER (USER-SPECIFIED)             MOD  xx

SOLID LOADING RATE (MAXIMUM)                xx.x       LB/SQ FT/DAY

SURFACE OVERFLOW RATE                       xx.x       G/SQ FT/DAY

SPECIFIC GRAVITY OF SLUDGE                  xx.x

UNDERFLOW CONCENTRATION                     xx.x       PERCENT

WEIR OVERFLOW RATE                          xx.x       G/FT/DAY

SIDEWATER DEPTH                             xx.x       FT

REMOVALS    SS = xx.x  BOD = xx.x  COD = xx.x  TKN = xx.x
  PO = xx.x                                            PERCENT

INFLUENT SUSPENDED SOLIDS[a]                xx.x       MG/L

RECTANGULAR CLARIFIER[b]

CIRCULAR CLARIFIER[b]

ESTIMATE[c]   STANDARD MECHANISM COST = xx.x

REPLACEMENT[d]  RSMS = xx.x   RSST = xx.x              YEARS

END
```

---

[a] Influent suspended solids should be specified. Default value is for an "average" activated sludge system.

[b] Use rectangular or circular clarifier, not both; default value = circular clarifier.

[c] Rectangular clarifier--cost of standard 20- by 120-ft clarifier mechanism; default value = $42,000. Circular clarifier--cost of standard 90-ft-diam clarifier mechanism; default value = $75,000.

[d] See Appendix F.

3-63. <u>Slow Infiltration Land Treatment</u>.

a. Design parameters for slow infiltration land treatment are listed below:

Average application rate = 0.5-4.0 in./wk

Maximum application rate = 0.10-0.50 in./hr

Desired nitrate percolate = 0.10-10.0 mg/ℓ

Runoff (site dependent) = 0.0 (should be specified 0.0 as runoff is generally negligible)

Buffer zone (site dependent) = 0.0-500.0 ft

Fraction of nitrogen loading denitrified = 15.0-25.0% (percent of total applied N)

Ammonia volatilization = 0.0% (percent of total applied N)

Removal of phosphorus = 80.0%

Slope on cultivated land $\le$ 20.0%

Slope on noncultivated land $\le$ 40.0%

b. Default data are given below:

```
FORAGE GRASSES
APPLICATION RATE (HYDRAULIC) AVERAGE  2.0 IN/WEEK  MAXIMUM  0.20 IN/HR
PRECIPITATION RATE                    0.8  IN/WEEK
DESIRED NITRATE PERCOLATE (MAX)      10.0  MG/L
EVAPOTRANSPIRATION RATE               0.4  IN/WEEK
RUNOFF                                0.0  IN/WEEK
WASTEWATER GENERATION PERIOD        365.0  DAYS/YR
FIELD APPLICATION PERIOD             52.0  WEEKS/YR
SOLID SET PIPING AND PUMPING
STORAGE REQUIRED                     30.0  DAYS
NO RECOVERY SYSTEM
BUFFER ZONE                           0.0  FEET
CURRENT GROUND COVER   FOREST  20.0 %  BRUSH 30.0 %  PASTURE 50.0%
SLOPE                                 2.0  PERCENT
MONITORING WELLS                   9 WELLS AT 10 FT/WELL
FENCING                              2.75  $/FT
FRACTION DENITRIFIED                 20.0  PERCENT OF APPLIED N
AMMONIA VOLATILIZATION                0.0  PERCENT OF APPLIED N
REMOVAL OF PHOSPHORUS                80.0  PERCENT OF APPLIED P
DAYS PER WEEK OPERATION               7.0  DAYS/WEEK
HOURS PER DAY OPERATION               8.0  HOURS/DAY
```

c. Slow infiltration land treatment unit process data cards are listed below:

SLOW INFILTRATION LAND TREATMENT MOD xx

FORAGE GRASSES[a] REVENUE = xx.x $/ACRE/YEAR

CORN[a] REVENUE = xx.x $/ACRE/YEAR

APPLICATION RATE AVERAGE = xx.x IN/WEEK
MAXIMUM = xx.x IN/HR

DESIRED NITRATE PERCOLATE (MAXIMUM) xx.x MG/L

PRECIPITATION RATE xx.x IN/WK

EVAPOTRANSPIRATION RATE xx.x IN/WK

RUNOFF xx.x IN/WK

WASTEWATER GENERATION PERIOD xx.x DAYS/YR

FIELD APPLICATION PERIOD xx.x WK/YR

SOLID SET PIPING[b]

CENTER PIVOT PIPING[b]

STORAGE REQUIRED[c] xx.x DAYS/YR

LINER REQUIRED[c] UPILL = xx.x $/SQ FT RSLL = xx.x YEARS

EMBANKMENT PROTECTION[c] CSBA = xx.x $/CU YD RSBA = xx.x YEARS

NO RECOVERY SYSTEM[d]

UNDERDRAIN RECOVERY SYSTEM[d]

(Continued)

---

[a] Use corn or forage grasses, not both; default value = forage grasses.

[b] Use solid set or center pivot, not both; default value = solid set.

[c] Liner or embankment protection should only be used with storage. UPILL = Cost of installed liner; RSLL = Service life of liner; CSBA = Cost of embankment protection; RSBA = Embankment protection service life.

[d] Use no recovery system or underdrains, not both; default value = no recovery system.

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BUFFER WIDTH xx.x FT

CURRENT GROUND COVER FOREST = xx.x% BRUSH = xx.x%
PASTURE = xx.x%

SLOPE xx.x PERCENT

MONITORING WELLS NO = xx.x DEPTH/WELL = xx.x FT

FENCING[e,f] COSFN = xx.x $/FT RSFN = xx.x YEARS

FRACTION DENITRIFIED xx.x PERCENT

AMMONIA VOLATILIZATION xx.x PERCENT

REMOVAL OF PHOSPHORUS xx.x PERCENT

HOURS PER DAY OPERATION xx.x HOURS

DAYS PER WEEK OPERATION xx.x DAYS

ESTIMATE[e] PS = xx.x SP = xx.x SV = xx.x EN = xx.x
CG = xx.x MW = xx.x PC = xx.x PP = xx.x

REPLACEMENT[f] RSPS = xx.x RSSP = xx.x RSSV = xx.x RSEN = xx.x
RSMW = xx.x RSPC = xx.x RSPP = xx.x RSST = xx.x YEARS

END

---

[e] PS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250. SP = Cost of 12-in. welded steel pipe, in place; default value = $12.80/ft. SV = Cost of 12-in. butterfly valve; default value = $952.10. EN = Cost of 6- to 15-gpm impact-type full circle sprinkler; default value = $61.65. CG = Cost of clearing and grubbing; default value = $3,000/acre (assumed for heavy clearing and grubbing). MW = Cost of 4-in. water well; default value = $8.00/ft. PC = Cost of center pivot 100-acre sprinkler system; default value = $27,690. PP = Cost of 6-in. perforated PVC pipe; default value = $6.94/ft. COSFN = Cost of fencing in $/ft; default value = $2.75/ft.

[f] See Appendix F.

3-64. Sludge Flotation.

a. Design parameters for sludge flotation are listed below:

Air pressure = 40-70 psig

Detention time in float tank = 3.0 hr

Solid loading (determine from laboratory tests)

Solid loading, lb/sq ft/day:

Type of Sludge	Solid Loading
Activated sludge (mixed liquor)	5 to 15
Activated sludge (settled)	10 to 20
50% primary +50% activated	20 to 40
Primary only	To 55

Hydraulic loading = 1.0-4.0 gal/min/sq ft

Recycle time in pressure tank = 1.0-3.0 min

Percent removal of solids (determine from bench test) = 80.0

Air/solids ratio (determine from laboratory test)

Float concentration (determine from bench test) = 3.0-5.0

Polymer dosage required = 1.0 lb/ton dry solids

b. Default data are given below:

```
AIR PRESSURE                     60          PSIG
DETENTION TIME IN FLOAT TANK     3           HRS
SOLID LOADING                    10.0          LB/SQFT/DAY
HYDRAULIC LOADING                2.5         GPM/SQFT
RECYCLE TIME IN PRESS TANK       2           MIN
PERCENT REMOVAL OF SOLIDS        80          PERCENT
AIR/SOLIDS RATIO                 0.02
FLOAT CONCENTRATION              4.0           PERCENT
POLYMER REQUIRED                 1 LB/TON
```

c. Sludge flotation unit process data cards are listed below:

AIR FLOTATION THICKENING MOD xx		
AIR PRESSURE	xx.x	PSIG
DETENTION TIME IN FLOAT TANK	xx.x	HOURS
SOLID LOADING	xx.x	LB/SQ FT/DAY
HYDRAULIC LOADING	xx.x	GPM/SQ FT
RECYCLE TIME IN PRESS TANK	xx.x	MIN
PERCENT REMOVAL OF SOLIDS	xx.x	PERCENT
AIR/SOLIDS RATIO	xx.x	
FLOAT CONCENTRATION	xx.x	PERCENT
POLYMER REQUIRED	xx.x	LB/TON
ESTIMATE[a] COSTFS = xx.x		
REPLACEMENT[b] RSFS = xx.x RSST = xx.x		YEARS
END		

---

[a] COSTFS = Cost of standard 350-sq-ft air flotation unit; default value = $44,200.

[b] See Appendix F.

3-65. Sludge Hauling and Land Filling.

a. Design parameters for sludge hauling and land filling are listed below:

Distance to disposal site (miles, one way)

Hours per day working schedule = 6.0-8.0 hr

Loading time per vehicle = 0.2-2.0 hr

Hauling time (includes unloading time)
(round trip hours)

b. Default data are given below:

DISTANCE TO DISPOSAL SITE	10 MILES
HOURS PER DAY	8 HOURS
LOADING TIME PER VEHICLE	0.75 HOURS
HAULING TIME PER TRIP	1.0 HOUR

c. Sludge hauling and land filling unit process data cards are listed below:

HAULING AND LAND FILLING	MOD xx	
DISTANCE TO DISPOSAL SITE	xx.x	MILES
HOURS PER DAY	xx.x	HOURS
LOADING TIME PER VEHICLE	xx.x	HOURS
HAULING TIME PER TRIP	xx.x	HOURS

ESTIMATE[a] COSTSSV = xx.x CYC = xx.x[b] CPCY = xx.x[b] CPT = xx.x[b]

REPLACEMENT[c] RSSV = xx.x RSST = xx.x YEARS

END

---

[a] COSTSSV = Cost of standard 22-cu-yd vehicle; default value = $51,700. CYC = Constant annual charge for land fill, $/yr. CPCY = Cost of sludge disposal per cubic yard, $/cu yd. CPT = Cost of sludge disposal per ton, $/ton.

[b] One of the three land fill charges must be specified; the others must be specified as 0.0. Default value is CYC = $8000/yr.

[c] See Appendix F.

3-66. Sludge Drying Lagoons.

a. Design parameters for sludge drying lagoons are listed below:

Solids loading rate = 2.2-2.4 lb/yr/cu ft

Depth of sludge in lagoon = 1.0 ft

b. Default data are given below:

```
SOLIDS LOADING RATE              2.30 LB/YEAR/CUFT
DEPTH OF SLUDGE IN LAGOON        1.0 FEET
```

c. Sludge drying lagoon unit process data cards are listed below:

SLUDGE DRYING LAGOONS	MOD xx	
SOLIDS LOADING RATE	xx.x	LB/YR/CU FT
DEPTH OF SLUDGE	xx.x	FT
ESTIMATE		
REPLACEMENT[a]	RSST = xx.x	YEARS
END		

---

[a] See Appendix F.

3-67. Step Aeration Activated Sludge.

a. Design parameters for Eckenfelder's approach are listed below:

Parameter	Suggested Values
K	Reaction rate constant = 0.0007-0.002 ℓ/mg/hr
A	Fraction of BOD synthesized = 0.73
A'	Fraction of BOD oxidized for energy = 0.52
B	Endogenous respiration rate (sludge basis) = 0.075/day
B'	Endogenous respiration rate (oxygen basis) = 0.15/day
F	Nonbiodegradable fraction of VSS in influent = 0.40
F'	Degradable fraction of the MLVSS = 0.53
ALPHA	O_2 transfer in waste/O_2 transfer in water = 0.90
BETA	O_2 saturation in waste/O_2 saturation in water = 0.90
HPR	Horsepower per 1000 gal $\geq$ 0.10 hp/1000 gal
F/M ratio	Food/microorganism ratio = 0.2-0.4
STE	Standard transfer efficiency Mechanical aerators = 2.0-3.5 lb O_2/hp-hr High speed = 2.0 Slow speed = 3.5 Diffused aerator = 6.0-11.0% Coarse bubble = 6.0 Fine bubble = 11.0

Additional parameters include:

Mixed liquor suspended solids = 2000-3500 mg/ℓ
Mixed liquor volatile solids = 1400-2450 mg/ℓ
Temperature correction coefficient = 1.0-1.04
Effluent BOD soluble = 10 mg/ℓ

b. Default data are given below:

```
CONSTANTS K=0.0012 A=0.73 AP=0.52 B=0.075 BP=0.15 F=0.4 FP=0.53
F/M RATIO                           0.3         LB BOD/LB VSS
MIXED LIQUOR   SS=2500   VS=1750                MG/L
TEMPERATURE COEFFICIENT             1.035
EFFLUENT BOD SOLUBLE               10           MG/L
DIFFUSED AERATION ALPHA=0.9 BETA=0.9 AF=20.0 CM/TG STE=6  PERCENT
```

c. Step aeration activated sludge unit process data cards are listed below:

STEP AERATION ACTIVATED SLUDGE[a] MOD xx

CONSTANTS K = xx.x A = xx.x A' = xx.x B = xx.x B' = xx.x
F = xx.x F' = xx.x

F/M RATIO xx.x LB BOD/LB VSS

MIXED LIQUOR SS = xx.x VS = xx.x MG/L

TEMPERATURE COEFFICIENT xx.x

EFFLUENT BOD SOLUBLE xx.x MG/L

MECHANICAL AERATION[b] ALPHA = xx.x BETA = xx.x
HPR = xx.x HPR/TG STE = xx.x LB O/HPR-HR

DIFFUSED AERATION[b] ALPHA = xx.x BETA = xx.x
AF[c] = xx.x CFM/TCUFT STE = xx.x PERCENT

ESTIMATE[d] SSXSA = xx.x COSTPD = xx.x COSTPH = xx.x
COSTPS = xx.x

REPLACEMENT[e] RSSA = xx.x RSPD = xx.x RSPH = xx.x
RSPS = xx.x RSST = xx.x YEARS

END

---

[a] User must also specify secondary clarification (activated sludge).

[b] Use mechanical or diffused, not both; default value = diffused. If mechanical aeration is specified, all data on mechanical card must be input.

[c] AF (minimum airflow) specifies a lower limit on airflow. Model will calculate actual airflow and compare it with input value. Higher value will be output. Input zero for AF to obtain calculated value only.

[d] SSXSA = Cost of standard slow-speed, pier-mounted 20-hp aerator; default value = $16,300. COSTPD = Cost of standard 12.0-scfm coarse-bubble diffuser; default value = $6.50. COSTPH = Cost of standard 550-scfm swing arm diffuser; default value = $5,000. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

[e] See Appendix F.

3-68. Trickling Filtration.

a. Design parameters for trickling filtration are listed below:

Solid production rate = 0.42-0.65 lb solids/lb BOD_5 applied

Hydraulic loading rate = 0.75 gpm/sq ft

Specific surface	
Surfpac	25-28 sq ft/cu ft

b. Default data are given below:

```
SOLID PRODUCTION RATE              0.45 LB/LB BOD
HYDRAULIC LOADING RATE             0.75 GPM/SQFT
SURFPAC                            26.0 SQFT/CUFT
EFFLUENT BOD                       30.0 MG/L
```

c. Trickling filter unit process data cards are listed below:

```
TRICKLING FILTER[a]                           MOD xx

SOLID PRODUCTION RATE                            xx.x         LB/LB BOD

EFFLUENT BOD                                     xx.x         MG/L

HYDRAULIC LOADING                                xx.x         GPM/SQ FT

SURFPAC       SPECIFIC SURFACE                   xx.x         SQ FT/CU FT

ESTIMATE[b]   UPFM = xx.x    CODAS = xx.x    COSTPS = xx.x

REPLACEMENT[c]   RSFM = xx.x    RSAS = xx.x
  RSPS = xx.x    RSST = xx.x                                  YEARS

END
```

---

[a] User should also specify secondary clarification (trickling filters).

[b] UPFM = Cost of selected media per cubic foot, installed; default value = \$2.50/cu ft. CODAS = Cost of standard 50-ft-diam distributor arm; default value = \$39,000. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = \$17,250.

[c] See Appendix F.

3-69. User-Specified Sludge Process.

a. In certain situations, the user may wish to adjust the sludge characteristics at some point within the treatment train. For these cases, the USER Specified sludge process is available. The USER Specified process is a sludge line process and is listed on the BLOCK card with the key word USER S. It may be used on either the primary or secondary sludge line. The user may specify a total reduction in the volume of sludge and the percent of volatile solids destroyed on the applicable sludge line. The cost data are user input and are of the same format as the cost override data.

b. User-specified sludge process data cards are listed below:

USER SPECIFIED SLUDGE PROCESS MOD xx

VOLUME REDUCTION xx.x PERCENT

PERCENT VS DESTROYED xx.x PERCENT

COST CAPITAL = xx.x OPER MAN HRS = xx.x
MAINT MAN HRS = xx.x POWER COST = xx.x
SUPPLY COST + xx.x CHEMICAL COST = xx.x

REPLACEMENT[a] RSST = xx.x YEARS

END

---

[a] RSST = Service life.

3-70. Vacuum Filtration.

a. Design parameters for vacuum filtration are listed below:

Chemical dosage (see Table 3-20)
Hours per day = 8.0-16.0 hr
Loading rate (see Table 3-21)

Table 3-20. Average Chemical Doses for Vacuum Filtration[a]

Type of Sludge	Chemical Dose Rate, percent		Polymer percent
	Ferric Chloride	Lime	
Raw primary	2.1	8.8	0.2-1.2
Digested primary	3.8	12.1	0.2-1.5
Elutriated digest primary	3.4	0.0	
Raw primary plus filter humus	2.6	11.0	0.2-1.2
Raw primary plus activated	2.6	10.1	0.5-2.0
Raw activated	7.5	0.0	
Digested primary plus filter humus	5.3	15.0	
Digested primary plus activated	5.6	18.6	
Elutriated digested primary plus activated:			
Average without lime	8.4	0.0	
Average with lime	2.5	6.2	

[a] Prepared by Burd (1968).

Table 3-21. Expected Performance of Vacuum Filters Handling Properly Conditioned Sludge[a]

Type of Sludge	Yield, $lb/ft^2/hr$
Fresh solids	
Primary	4 to 12
Primary plus trickling filter	4 to 8
Primary plus activated	4 to 5
Activated (alone)	2.5 to 3.5
Digested solids (with or without elutriation)	
Primary	4 to 8
Primary plus trickling filter	4 to 5
Primary plus activated	4 to 5

[a] Prepared by Simpson (1964), courtesy of Water Pollution Control Federation.

b. Default data are given below:

```
LIME                              10          PERCENT DRY WT
DAYS PER WEEK                     5           DAYS
HOURS PER DAY                     8           HOURS
LOADING RATE             3.5      LB/SQFT/HR
```

c. Vacuum filtration unit process data cards are listed below:

VACUUM FILTRATION MOD xx		
HOURS PER DAY OF OPERATION	xx.x	HR/DAY
DAYS PER WEEK OF OPERATION	xx.x	DAYS/WK
LOADING RATE	xx.x	LB/SQ FT/HR
LIME[a]	xx.x	PERCENT DRY WT
POLYMER[a]	xx.x	PERCENT DRY WT
IRON SALTS[a]	xx.x	PERCENT DRY WT
ESTIMATE[b] COSTSF = xx.x		
REPLACEMENT[c] RSSF = xx.x RSST = xx.x		YEARS
END		

---

[a] Use only one of lime, polymer, or iron salts cards; default value = lime.

[b] COSTSF = Cost of standard 300-sq-ft vacuum filter; default value = $150,000.

[c] See Appendix F.

3-71. Wet Oxidation.

a. Design parameters for wet oxidation are listed below:

Sludge COD = 20.0-40.0 mg/ℓ

Saturated stream pressure (determine from standard steam tables; see Figure 3-5 below) = 600.0-3000.0 psia

Specific volume of saturate steam (determine from standard steam tables; see Figure 3-5 below)

COD removed = 60.0-90.0%

Temperature of reactor = 250.0-700.0°F

Retention time (from Figure 3-5)

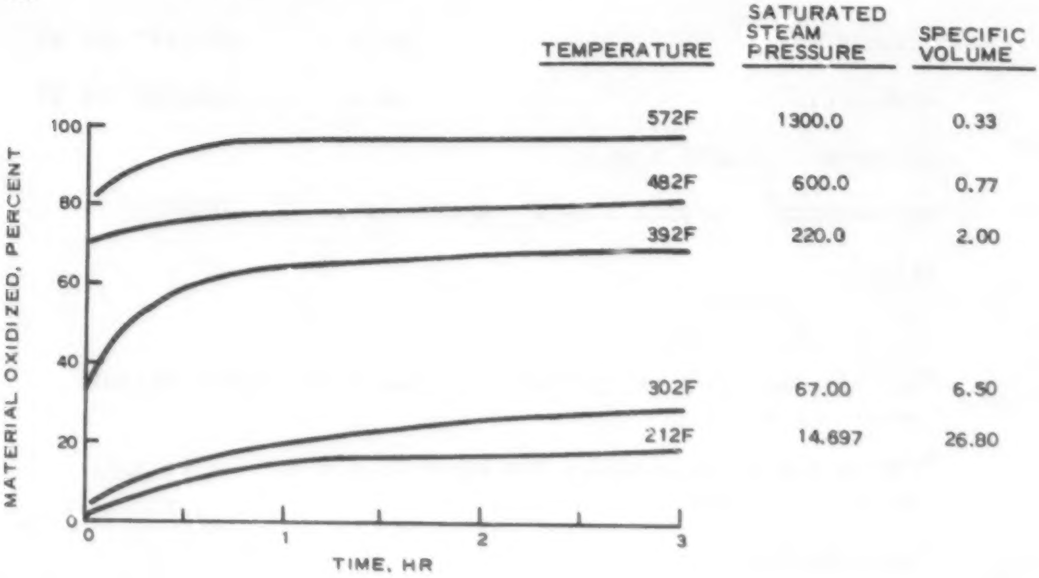

Figure 3-5. Material oxidized versus time at various temperatures. (courtesy of American Society of Civil Engineers 1959); "Sludge Treatment and Disposal by the Zimmerman Process," Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 85, No. SA4, Part 1, July 1959)

b. Default data are given below:

```
SLUDGE COD                        30.0  MG/L
SATURATED STEAM PRESSURE         600.0  PSIA
SPECIFIC VOLUME OF STEAM          0.77  CUFT/LB
COD REMOVED                       75.0  PERCENT
TEMPERATURE                      482.0  DEGREES F
RETENTION TIME                     1.0  HOURS
```

c. Wet oxidation unit process data cards are listed below:

WET OXIDATION[a] MOD xx		
SLUDGE COD	xx.x	GM/L
SATURATED STEAM PRESSURE	xx.x	PSIA
SPECIFIC VOLUME OF SATURATED STEAM	xx.x	CU FT/LB
RETENTION TIME	xx.x	HOURS
COD REMOVED	xx.x	GM/L
TEMPERATURE OF REACTOR	xx.x	DEG F
REPLACEMENT[b]	RSST = xx.x	YEARS
END		

---

[a] This unit process is parametrically costed.

[b] See Appendix F.

CHAPTER 4

SMALL FACILITY UNIT PROCESS SPECIFICATION

4-1. Introduction.

a. General. Specific input data for each small facility unit process are included in this chapter. The unit process specifications included in this chapter should be used only if a SMALL FACILITY card was specified as the first card of input data. Each line of data that may be included for a particular unit process is shown along with the proper units. Each line of data under each unit process in this chapter corresponds to one card or line of input to the model. It is permissible to interchange whole lines of data; however, within each line the data must appear on the card or line in the exact order shown. The unit process name (header card) and the END card must be the first and last lines or cards, respectively, for each unit process.

b. Estimate Costing. All small facility unit processes use the estimate costing approach. This costing technique is described in paragraph 3-1b.

c. ESTIMATE Card. The ESTIMATE card which may optionally be included in the unit process input data specifies that estimate type costing is to be used for the particular process. In general, the data on this card will include the cost of one or more standard size items of equipment. Costs of the required sizes of these items of equipment will be generated within the program. If the user elects to specify the costs of these items, he should use the current cost of the standard size unit. If these costs are omitted from the ESTIMATE card or are specified as zero, the program will use the first quarter 1977 cost updated by the Marshall and Swift equipment cost index specified in the unit cost input.

d. Default Data. Default data have been included within the program for the three modifications of all unit processes included within CAPDET. Thus, for the modification of these processes it is necessary to include data only for those data items the user wishes to change. To change one or more data items the user should specify a unit process header card for the modification number of the process followed by data cards for those items the user wishes to change. An END card will conclude input of data for that process.

e. REPLACEMENT Card. Detailed cost analysis requires consideration of equipment and structural component service lives. The REPLACEMENT card, which may be used as an optional unit process data input, allows the user to specify service lives of various components. Since in general the user will prefer to use default data and for the sake of convenience in manual formatting, a detailed explanation of the REPLACEMENT card variables is included in Appendix F rather than on the unit process specification page.

4-2. Activated Sludge.

a. Design parameters for activated sludge are listed below:

Detention time = 18.0-36.0 hr

Solids detention time = 20.0-30.0 days

Underflow concentration = 10,000-12,000 mg/ℓ

Additional parameters include:

Parameter	Suggested Values
K_m	Metabolism constant = 15.0/hr at 20°C
K_s	Synthesis factor = 10.4/hr at 20°C
K_e	Endogenous respiration factor = 0.02/hr at 20°C
THETA	Temperature correction coefficient = 1.0-1.03

b. Default data are given below:

```
CONSTANTS   KM=15.0  KS=10.4  KE=0.02  THETA=1.02
DETENTION TIME                         30.0 HOURS
SOLIDS DETENTION TIME                  25.0 DAYS
DESIRED EFFLUENT   BOD=25.0  SS=30.0  TKN=10.0  PO=15.0
UNDERFLOW CONCENTRATION                10000.0 MG/L
```

c. Activated sludge unit process data cards are listed below:

ACTIVATED SLUDGE[a] MOD xx

CONSTANTS KM = xx.x KS = xx.x KE = xx.x THETA = xx.x

DETENTION TIME xx.x HOURS

SOLIDS DETENTION TIME xx.x DAYS

DESIRED EFFLUENT [illegible] SS = xx.x TKN = xx.x
PO = xx.x MG/L

UNDERFLOW CONCENTRATION xx.x MG/L

ESTIMATE[b] COSTSP = xx.x

REPLACEMENT[c] RSSP = xx.x RSST = xx.x YEARS

END

---

[a] Small systems activated sludge assumes package plant construction.

[b] COSTSP = Cost of a standard 100,000-gpd package extended aeration activated sludge plant; default value = $36,500.

[c] See Appendix F.

4-3. Aerated Lagoons.

a. Design parameters for Eckenfelder's approach are listed below:

Parameter	Suggested Values
K	Reaction rate constant; aerobic = 0.0007-0.002 ℓ/mg/hr; facultative = 0.50-1.00 per day
A	Fraction of BOD synthesized = 0.73
AP	Fraction of BOD oxidized for energy = 0.52
B	Endogenous respiration rate (sludge basis) = 0.075/day
BP	Endogenous respiration rate (oxygen basis) = 0.15/day
P	Pressure correction factor = 1.0
ALPHA	O_2 transfer in waste/O_2 transfer in water = 0.90
BETA	O_2 saturation in waste/O_2 saturation in water = 0.90
THETA	Temperature coefficient; aerobic = 1.035; facultative = 1.075
HPR	Minimum horsepower required for mixing ≥ 0.06 hp/1000 gal
STE	Standard transfer efficiency Mechanical aerators = 2.0-3.5 lb O_2/hp-hr High speed = 2.0 Slow speed = 3.5

Additional parameters include:

Detention time = 2-4 days
Mixed liquor suspended solids (facultative) = 70-200 mg/ℓ
Mixed liquor volatile suspended solids (facultative) = 50-150 mg/ℓ

b. Default data are given below:

```
SUMMER TEMPERATURE                    23.0 DEG C
WINTER TEMPERATURE                    10.0 DEG C
EFFLUENT BOD SOLUBLE                  10.0 MG/L
MINIMUM DISSOLVED OXYGEN               3.0 MG/L
CONSTANTS K=0.00135 A=0.73 AP=0.52 B=0.075 BP=0.15 THETA=1.035 P=1.0
MECHANICAL AERATION  ALPHA=0.9  BETA=0.9  HPR=0.06  STE=2.0
DETENTION TIME                         3.0 DAYS
LINER COST                            0.70 $/SQ FT
MIXED LIQUOR      SS=400.0 MG/L   VSS=320.0 MG/L
AERATED LAGOON
COMPLETE MIX AERATED LAGOON
```

c. Aerated lagoon unit process data cards are listed below:

AERATED LAGOONS MOD xx

SUMMER TEMPERATURE xx.x DEG C

WINTER TEMPERATURE xx.x DEG C

EFFLUENT SOLUBLE BOD xx.x MG/L

CONSTANTS K = xx.x A = xx.x AP = xx.x B = xx.x
BP = xx.x THETA = xx.x P = xx.x

MECHANICAL AERATION ALPHA = xx.x BETA = xx.x
HPR = xx.x HPR/TGAL STE = xx.x LB O_2/HPR-HR

DETENTION TIME (HYDRAULIC)[a] xx.x DAYS

MINIMUM DISSOLVED OXYGEN xx.x MG/L

LINER REQUIRED[b] UPILL = xx.x \$/SQ FT RSLL = xx.x YEARS

COMPLETE MIX AERATED LAGOON[c]

FACULTATIVE AERATED LAGOON[c]

MIXED LIQUOR[d] SS = xx.x VS = xx.x MG/L

ESTIMATE[e] COSTSA = xx.x

REPLACEMENT[f] RSSA = xx.x RSST = xx.x YEARS

END

---

[a] Hydraulic detention time is a minimum detention time. Detention time will be calculated based on summer and winter temperatures. The larger of the hydraulic detention time and the two calculated detention times will be used.

[b] Liner is optional; UPILL = Cost of installed liner; default value = \$0.30/sq ft; delete by using UPILL = \$0.00/sq ft; RSLL = liner service life; default value = 15 years.

[c] Use complete mix or facultative, not both; default value = complete mix.

[d] Use only with facultative lagoons; will be calculated in complete mix lagoons.

[e] COSTSA = Cost of a standard 50-hp high-speed floating aerator; default value = \$13,960.

[f] See Appendix F.

4-4. Bar Screens.

a. Design parameters for bar screens are listed below:

Bar shape factor:

Sharp-edged rectangular bars = 2.42

Rectangular bars with semicircular upstream faces = 1.83

Circular bars = 1.79

Rectangular bars with semicircular upstream and downstream faces = 1.67

Wet season factor = local condition reflecting ratio of peak wet season flow to average flow

Bar screen sizes:

Width = 1/4-5/8 in.

Depth = 1-3 in.

Spacing = 5/8-3 in.

Slope from vertical = 0-30 deg

Approach velocity = 2-3 fps

Allowable head loss = 6 in.

b. Default data are given below:

```
WET SEASON FACTOR                    3.50
BARS   WIDTH=0.3125 IN  SPACING=1.0 IN THETA=10.0 DEG SHAPE=1.67
MAXIMUM HEAD LOSS THRU SCREEN        0.50 FEET
```

c. Bar screen unit process data cards are listed below:

```
SCREENS                                    MOD  xx

WET SEASON FACTOR                               xx.x

BARS   WIDTH = xx.x    SPACING = xx.x    THETA = xx.x
  SHAPE FACTOR = xx.x

MAXIMUM HEAD LOSS THRU SCREEN                   xx.x    FT

ESTIMATE[a]

REPLACEMENT[b]   RSTB = xx.x  RSST = xx.x   YEARS

END
```

---

[a] COSTB = Cost of a standard 2-ft mechanically cleaned bar screen unit; default value = $10,350.

[b] See Appendix F.

4-5. Charge Calculation Data.

a. Data for calculating user charges are listed below:

(1) EPA grant is assumed to be 75% for conventional mechanical treatment systems.

(2) State grant assumed as 0%.

(3) Allowance for financing represents extra cost associated with issuance of bonds.

(4) Revenue, general obligation, or other sources of interest-bearing funds may be spcified as means of financing the local share. These bonds or loans may have varying interest rates or life.

(5) Gallons per capita per day represents water usage and is assumed to be 100 gpcd.

b. Default data are given below:

```
EPA GRANT                        75.0       85.0  PERCENT
ALLOWANCE FOR FINANCING                      3.0  PERCENT
REVENUE BONDS          100.0 %   10.0 %      20   YEARS
PERSONS PER HOUSEHOLD                        3.5
GALLONS PER CAPITA PER DAY                 100.0  GPCD
```

c. Charge calculations data cards are listed below:

CHARGE CALCULATIONS

EPA GRANT xx.x PERCENT xx.x LAND TREATMENT PERCENT

STATE GRANT xx.x PERCENT

ALLOWANCE FOR FINANCING xx.x PERCENT

REVENUE BONDS[a,b] PLS = xx.x I = xx.x N = xx.x

GENERAL OBLIGATION BONDS[a,b] PLS = xx.x I = xx.x N = xx.x

OTHER BONDS OR LOANS[a,b] PLS = xx.x I = xx.x N = xx.x

EXISTING BILLING INFORMATION[c] NUMBER OF BILLING UNITS xx.x BU
BILLING UNIT RATE xx.x $/BU

CURRENT SYSTEM ANNUAL OPERATION AND MAINTENANCE xx.x $/YEAR

PERSONS PER HOUSEHOLD xx.x

GALLONS/CAPITA/DAY xx.x GPCPD

END

---

[a] PLS = Percent of local share,
I = Interest rates,
N = Maturity in years.

[b] Any combination of these cards may be used. The sum of the percentages of the local share should be 100%.

[c] Usually based on water sold.

4-6. Chlorination.

a. Design parameters for chlorination are listed below:

Contact time at peak flow > 15.0 min

Length to width ratio = 40.0 to 1.0 approaches plug flow

Sidewater depth = 8.0 ft

Chlorine dosage = 8.0-10.0 mg/ℓ

b. Default data are given below:

CONTACT TIME AT PEAK FLOW	30.0 MINS
LENGTH TO WIDTH RATIO	40.0
CHEMICAL DOSAGE	8.0 MG/L
SIDEWATER DEPTH	8.0 FEET

c. Chlorination unit process data cards are listed below:

```
CHLORINATION                              MOD  xx

CONTACT TIME AT PEAK FLOW                      xx.x       MIN

LENGTH TO WIDTH RATIO                          xx.x

CHEMICAL DOSAGE                                xx.x       MG/L

SIDEWATER DEPTH                                xx.x       FT

ESTIMATE^a     CHLCO = xx.x    $/TON    COSTCL = xx.x

REPLACEMENT^b   RSCL = xx.x    RSST = xx.x                YEARS

END
```

---

[a] CHLCO = Cost of chlorine per ton; default value = $100.
COSTCL = Cost of standard 2000-lb/day chlorinator; default value = $2,700.

[b] See Appendix F.

4-7. Coagulation.

a. Design parameters for coagulation are listed below:

Suspended solids effluent = 85.0-95.0%

Phosphorus effluent = 40.0-60.0%

Surface loading rate = 600.0-800.0 gal/day/sq ft

Underflow concentration = 5.0%

Dosage and pH (see below)

Coagulant	Coagulant Dose mg/ℓ	Optimum pH
Lime	200.0-500.0	10.0-11.0
Alum	50.0-100.0	5.0-6.5
Iron Salts	100.0-250.0	5.0-6.5

b. Default data are given below:

```
LIME DOSAGE                                250.0 MG/L
DESIRED EFFLUENT   SS=90.0 MG/L  PO=50.0 MG/L
SURFACE LOADING RATE                       800.0 GAL/DAY/SQFT
REMOVAL RATES  BOD=60.0  COD=60.0  TKN=40.0  PERCENT
OPTIMUM PH                                 10.5
UNDERFLOW CONCENTRATION                    5.0 PERCENT
```

c. Coagulation unit process data cards are listed below:

```
COAGULATION[a]                          MOD xx
LIME DOSAGE[b]                              xx.x          MG/L
ALUM DOSAGE[b]                              xx.x          MG/L
IRON SALT DOSAGE[b]                         xx.x          MG/L
DESIRED EFFLUENT      SS = xx.x     PO = xx.x             MG/L
SURFACE LOADING RATE                        xx.x          G/DAY/SQ FT
REMOVAL RATES    BOD = xx.x   COD = xx.x   TKN = xx.x     PERCENT
OPTIMUM PH                                  xx.x
UNDERFLOW CONCENTRATION                     xx.x          PERCENT
ESTIMATE[c]     COSTCL = xx.x
REPLACEMENT[d]     RSCL = xx.x    RSST = xx.x             YEARS
END
```

---

[a] Process design primarily oriented toward removal of algae from lagoon effluents.

[b] Use only one of lime, alum, or iron cards; default value = lime.

[c] COSTCL = Cost of standard 60-ft upflow clarifier; default value = $110,000.

[d] See Appendix F.

4-8. Cost Overrides.

a. Within the unit process specification input section, the user has the option of supplying unit process costs which are deemed to be more accurate than those which will be generated by CAPDET. Data coding for these cost overrides consist of a cost header card followed by one data card for each unit process for which the user wishes to supply costs. Cost overrides may be supplied for a maximum of 30 unit processes. The input of unit process cost overrides will be terminated with an END card.

b. The unit process will be identified by the unit process keyword as listed on pages 2-9 through 2-10. The right cost override data items which may be included for each unit process are as follows:

(1) The modification number: The modification number must be specified even if modification zero is used.

(2) Capital cost of the unit process in present-day dollars.

(3) Annual operational man-hours in man-hours per year.

(4) Annual maintenance man-hours in man-hours per year.

(5) Annual power cost in present-day dollars per year.

(6) Annual supply cost in present-day dollars per year.

(7) Annual chemical cost in present-day dollars per year.

(8) Design life (replacement schedule) in years. If the design life is omitted (or input as zero), the design life of the treatment plant (as specified on the GO card) will be used.

c. The COSTS section is loaded with the value of -1.0 in all eight data items. These values are simply space fillers which represent no cost override options. To override CAPDET cost estimates, the user would substitute the eight items for the -1.0 values.

EXAMPLE

```
COST OVERRIDES (header card)

AERATED LAGOON          0      -1    -1    -1    -1   1200   -1   30

CHLORINATION            1   86870   700   400     0      0    0

PRIMARY CLARIFICATION   0       0     0     0     0      0    0    0

END
```

This example illustrates three unit processes which will use the cost override option. For the aerated lagoon modification zero, only the annual supply cost is overridden. A design life of 30 years will be used for the lagoon. For the modification one chlorination unit, the CAPDET values for capital cost, operation man-hours, and maintenance man-hours will be overridden with the values $86870 and 700 and 400 man-hours per year, respectively. Annual power cost, supply cost, and chemical cost are zero, and the replacement schedule of the chlorination unit will be equal to the treatment plant life. For the primary clarification modification zero unit process, all items are overridden with zeros. This may be an existing unit where it is necessary to evaluate the characteristics of the waste stream through the existing facility, but it is unnecessary to include the unit process in the system cost evaluation.

d. **Cost override data cards are listed below:**

Key Word	MOD Number	Capital Cost, $	Operation Man-Hours Hr/Year	Maint Man-Hours Hr/Year	Power Cost $/Year	Supply Cost $/Year	Chemical Cost $/Year	Design Life Years
COSTS[a,b]								
ACTIVATED SLUDGE	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
AERATED LAGOON	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
CHLORINATION	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
COAGULATION	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
DRYING BEDS	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
DUMMY PROCESS	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
EQUALIZATION	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
FILTRATION	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
FLOTATION	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
INTERMITTENT SAND FILTER	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
OVERLAND FLOW LAND TREATMENT	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
O SECONDARY CLARIFICATION (OXIDATION DITCH)	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
OXIDATION DITCH	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
POSTAERATION	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
PRIMARY CLARIFICATION	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
RAPID INFILTRATION LAND TREATMENT	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
RAW SEWAGE PUMPING	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
SCREENS	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
SEPTIC TANKS	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
SLOW INFILTRATION LAND TREATMENT	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
SLUDGE DRYING LAGOONS	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
T SECONDARY CLARIFICATION (TRICKLING FILTER)	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
TRICKLING FILTRATION	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X	XX.X
END								

---

[a] List only those lines describing the unit process whose cost functions are to be replaced.

[b] If all values are not changed in a line, the other values must be reset to -1.0.

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4-9. Sludge Drying Beds.

a. Design parameters for sludge drying beds are listed below:

Type of Sludge	Solids Loading Rate Units lb/ft^2/yr
Primary	27.5
Primary + trickling filter	22.0
Primary + activated	15.0
Chemically precipitated	22.0

b. Default data are given below:

SOLIDS LOADING RATE	15.0 LBS/SQFT/YEAR

c. Sludge drying bed unit process data cards are listed below:

DRYING BEDS MOD xx

SOLIDS LOADING RATE xx.x LB/SQ FT/YR

ESTIMATE[a] COSTCP = xx.x COSAND = xx.x $/CU YD
COGRVL = xx.x $/CU YD

REPLACEMENT[b] RSCP = xx.x RSST = xx.x YEARS

END

---

[a] COSTCP = Cost of installed 6-in. perforated clay pipe; default value = $2.75/ft. COSAND = Cost of sand; default value = $5.90/cu yd. COGRVL = Cost of gravel; default value = $4.30/cu yd.

[b] See Appendix F.

4-10. Dummy Process.

a. In certain situations, the user may wish to adjust the waste characteristics at some point within the train (to simulate side flows, new processes, etc.). For these cases, the DUMMY process is available. The DUMMY process is a liquid line process and is listed on the BLOCK card with the key word DUMMY. The data cards for the DUMMY process are shown on the following page. The parameters of flow, temperature, and pH are set to describe the waste stream at that point in the train. All other waste characteristic parameters are modified as percent reductions of that particular parameter from the value it possessed as influent to the DUMMY process. The cost data are user input and the data card is of the same format as the cost override card. The sludge lines can be modified to indicate sludge production at that point in the train by inputting values for volume of sludge, percent solids of sludge, and volatile portion of the sludge. If the sludge cards are included, all three values must be present and in the proper order.

b. The values Q_i, C_i, T_i, and pH_i are waste descriptors that are either input by the user, if it is at the head of the plant, or are effluent characteristics generated by the flow through previous processes. Since for the DUMMY process there is no standard design and cost formulation within CAPDET, the user must simulate the effect of the process on the waste stream. This is done by setting Q_i, T_i, pH_i, sludge volumes, and costs and describing the C_e's as percent reductions of the C_i's.

c. Dummy process data cards are listed below:

Key Word	Value	Units
DUMMY PROCESS		
MINIMUM FLOW	xx.x	MGD
AVERAGE FLOW FINAL xx.x INITIAL	xx.x	MGD
MAXIMUM FLOW	xx.x	MGD
TEMPERATURE SUMMER xx.x WINTER	xx.x	DEG C
SUSPENDED SOLIDS	xx.x	PER RED
VOLATILE SOLIDS	xx.x	PER RED
BOD5	xx.x	PER RED
SBOD (SOLUBLE)	xx.x	PER RED
COD xx.x	PER RED	
SCOD (SOLUBLE)	xx.x	PER RED
PH xx.x	UNITS	
CATIONS	xx.x	PER RED
ANIONS	xx.x	PER RED
TKN xx.x	PER RED	
PO4 xx.x	PER RED	
NH3 xx.x	PER RED	
SETTLEABLE SOLIDS	xx.x	PER RED
OIL AND GREASE	xx.x	PER RED
NO2 xx.x	PER RED	
NO3 xx.x	PER RED	
PRIMARY SLUDGE xx.x GAL/DAY xx.x PER SOLIDS xx.x PER VOLATILE		
SECONDARY SLUDGE xx.x GAL/DAY xx.x PER SOLIDS xx.x PER VOLATILE		
COSTS CAPITAL xx.x OPER MAN HRS xx.x MAINT MAN HRS xx.x POWER xx.x SUPPLY COST xx.x CHEMICAL COSTS xx.x DESIGN LIFE xx.x		
REPLACEMENT[a]	RSST = xx.x	YEARS
END		

---

[a] See Appendix F.

4-11. Equalization.

a. Design parameters for equalization are listed below:

Parameter	Suggested Value
ALPHA	O_2 transfer in waste/O_2 transfer in water = 0.9
BETA	O_2 saturation in waste/O_2 saturation in water = 0.9
HPR	Aerator mixing requirements = 0.02-0.04 hp/1000 gal
STE	Standard transfer efficiency = 5.0 lb O_2/hp-hr

Additional parameters include:

Oxygen requirements = 15.0 mg/ℓ/hr

Pressure correction coefficient = 1.0

Dissolved oxygen to be maintained in basin = 2.0 mg/ℓ

Depth of basin > 5.0 ft due to aerator operation

b. Default data are given below:

```
MECHANICAL AERATION ALPHA=0.9 BETA=0.9 HPR=0.03 HPR/TG STE=5.0 LB O/HPR/HR
OXYGEN REQUIREMENTS                 15.0 MG/L/HOUR
PRESSURE COEFFICIENT                1.0
SUMMER TEMPERATURE                  27 DEG C
DISSOLVED OXYGEN                    2.0 MG/L
DEPTH OF BASIN                      6.0 FEET
EARTHEN BASIN                       0.30 $/SQFT
```

c. Equalization unit process data cards are listed below:

EQUALIZATION MOD xx

MECHANICAL AERATION ALPHA = xx.x BETA = xx.x
HPR = xx.x STE = xx.x

OXYGEN REQUIREMENTS xx.x MG/L/HR

PRESSURE COEFFICIENT xx.x

SUMMER TEMPERATURE xx.x DEG C

DISSOLVED OXYGEN xx.x MG/L

DEPTH OF BASIN xx.x FEET

FLOWS[a,b] xx.x xx.x xx.x xx.x xx.x GAL/HR

VOLUME OF BASIN[b] xx.x MG

CONCRETE BASIN[c]

EARTHEN BASIN[c,d] LINER COST = xx.x $/SQ FT RSLL = xx.x YEARS

ESTIMATE[e] COSTSA = xx.x

REPLACEMENT[d] RSSA = xx.x RSST = xx.x YEARS

END

---

[a] More than one FLOW card may be used. Any number of hourly flows may be included on each FLOW card. A maximum of 24 hourly flows may be input.

[b] Use either FLOW cards or a VOLUME card to determine the required volume of the basin. If neither are specified, the volume will be defaulted to 20 percent of the average flow.

[c] Use earthen lined or concrete lined, not both; default value = earthen lined.

[d] RSLL = Service life of liner. See Appendix F.

[e] COSTSA = Cost of standard 50-hp, high-speed floating aerator; default value = $13,960.

4-12. Filtration.

a. Design parameters for filtration are listed below:

Hydraulic loading rate = 3.5-6.0 gpm/sq ft

Backwash rate = 20 gpm/sq ft (minimum)

Backwash period = 10 min (minimum)

Number of backwash volumes = 2

b. Default data are given below:

```
HYDRAULIC LOADING RATE             5.0 GPM/SQFT
NUMBER OF FILTER CELLS             4
BACKWASH     RATE=20.0 GPM/SQFT  PERIOD=10.0 MIN
VOLUMES OF BACKWASH WATER           2
```

c. Filtration unit process data cards are listed below:

FILTRATION MOD xx

HYDRAULIC LOADING RATE xx.x GPM/SQ FT

NUMBER OF FILTER CELLS xx.x

BACKWASH RATE = xx.x GPM/SQ FT PERIOD = xx.x MIN

VOLUMES OF BACKWASH REQUIRED[a] xx.x

ESTIMATE[b] COSTSF = xx.x

REPLACEMENT[c] RSSF = xx.x RSST = xx.x YEARS

END

---

[a] Input specifies the number of backwash volumes required; default value = 2.

[b] COSTSF = Cost of a standard 120-sq-ft package multimedia filter unit including blowers, backwash pumps, under-drain system, backwash troughs, filter media, control panel, valving and piping to connect cells, and steel tanks; default value = $73,760.

[c] See Appendix F.

4-13. Flotation.

a. Design parameters for flotation are listed below:

Air to solids ratio = 0.01-0.03

Air pressure = 40.0-60.0 psig

Detention time in float tank = 0.25-0.5 hr

Detention time in pressure tank = 1.0-3.0 min

Hydraulic loading rate = 1.0-4.0 gpm/sq ft

Float concentration = 3.0-5.0%

Specific gravity = 1.02

Lime dosage = 300.0-500.0 mg/ℓ

Alum dosage = 50.0-150.0 mg/ℓ

Iron salts dosage = 50.0-150.0 mg/ℓ

Polymer dosage = 5.0-10.0 mg/ℓ

b. Default data are given below:

```
AIR/SOLIDS RATIO                   0.02
AIR PRESSURE                       40.0 PSIG
DETENTION TIMES     FLOAT=0.50 HOURS   PRESSURE=3.0 MINS
HYDRAULIC LOADING RATE             2.0 GPM/SQFT
FLOAT CONCENTRATION                3.0 PERCENT
SPECIFIC GRAVITY                   1.02
ALUM DOSAGE                        100.0 MG/L
REMOVAL RATES  SS=80.0 BOD=30.0 COD=30.0 TKN=10.0 PO=10.0 PERCENT
```

c. Flotation unit process data cards are listed below:

```
FLOTATION[a]                           MOD  xx

AIR/SOLIDS RATIO                            xx.x

AIR PRESSURE                                xx.x      PSIG

DETENTION TIMES    FLOAT = xx.x  HRS   PRESSURE = xx.x  MIN

HYDRAULIC LOADING RATE                      xx.x      GPM/SQ FT

FLOAT CONCENTRATION                         xx.x      PERCENT

SPECIFIC GRAVITY                            xx.x

LIME DOSAGE[b]                              xx.x      MG/L

ALUM DOSAGE[b]                              xx.x      MG/L

IRON SALTS DOSAGE[b]                        xx.x      MG/L

POLYMER DOSAGE[b]                           xx.x      MG/L

REMOVAL RATES     SS = xx.x    BOD = xx.x     COD = xx.x
  TKN = xx.x      PO = xx.x     PERCENT

ESTIMATE[c]     COSTSF = xx.x

REPLACEMENT[d]    RSSF = xx.x   RSST = xx.x              YEARS

END
```

---

[a] This unit is designed primarily for algae removal from lagoon effluent.

[b] Use only one of lime, alum, iron salts, or polymer; default value = alum.

[c] COSTSF = Cost of a standard 350-sq-ft dissolved air flotation unit; default value = $44,200.

[d] See Appendix F.

4-14. Intermittent Sand Filter.

a. Design parameters for intermittent sand filter are listed below:

Hydraulic loading rate = 200,000-800,000 gal/acre/day

Depth of filter bed = 24.0-36.0 in.

b. Default data are given below:

NUMBER OF FILTER BEDS	3
HYDRAULIC LOADING RATE	500000.0 GAL/ACRE/DAY
DEPTH OF FILTER BEDS	30.0 INCHES

c. Intermittent sand filter unit process data cards are listed below:

INTERMITTENT SAND FILTER[a] MOD xx

NUMBER OF FILTER BEDS xx.x

HYDRAULIC LOADING RATE xx.x GAL/ACRE/DAY

DEPTH OF FILTER BED xx.x INCHES

ESTIMATE[b] COSAND = xx.x $/CU YD COGRVL = xx.x $/CU YD
COSTCP = xx.x COSTSP = xx.x

REPLACEMENT[c] RSCP = xx.x RSSP = xx.x RSST = xx.x YEARS

END

---

[a] Intermittent sand filter should be used primarily for algae removal from lagoon effluent

[b] COSAND = Cost of sand; default value = $5.90/cu yd. COGRVL = Cost of gravel; default value = $4.30/cu yd. COSTCP = Cost of installed 6-in. perforated clay pipe; default value = $2.75/ft. COSTSP = Cost of 12-in.-diam welded steel pipe; default value = $12.80/ft.

[c] See Appendix F.

4-15. Lagoons.

a. Design parameters for lagoons are presented in Table 4-1:

Table 4-1. Design Parameters for Stabilization Ponds[a]

Parameter	Type of Pond			
	Aerobic[b]	Facultative	Facultative	Anaerobic
Flow regime	Intermittently mixed	--	Mixed surface layer	--
Pond size, acres	<10 multiples	2 to 10 multiples	2 to 10 multiples	0.5 to 2.0 multiples
Operation[c]	Series or parallel	Series or parallel	Series or parallel	Series
Detention time, days[c]	10 to 40	7 to 30	7 to 20	20 to 50
Depth, ft	3 to 4	3 to 6	3 to 8	8 to 15
pH	6.5 to 10.5	6.5 to 9.0	6.5 to 8.5	6.8 to 7.2
Temperature range, °C	0 to 40	0 to 50	0 to 50	6 to 50
Optimum temperature, °C	20	20	20	30
BOD_5 loading, lb/acre/day[d]	60 to 120[e]	15 to 50	30 to 100	200 to 500
BOD_5 conversion	60 to 70	60 to 70	60 to 70	50 to 70
Principal conversion products	Algae, CO_2, bacterial cell tissue	Algae, CO_2, CH_4, bacterial cell tissue	CO_2, CH_4, bacterial cell tisue	CO_2, CH_4, bacterial cell tissue
Algal concentration, mg/ℓ	80 to 200	40 to 160	10 to 40	--
Effluent suspended solids, mg/ℓ[f]	140 to 340	160 to 400	110 to 340	80 to 160

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering: Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972, by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

[b] Conventional aerobic ponds designed to maximize the amount of oxygen produced rather than the amount of algae produced.

[c] Depends on climatic conditions.

[d] Typical values (much higher values have been applied at various loadings). Loading values are often specified by state control agencies.

[e] Some states limit this figure to 50 or less.

[f] Includes algae, microorganisms, and residual influent suspended solids. Values are based on an influent soluble BOD_5 of 200 mg/ℓ and, with the exception of the aerobic ponds, an influent suspended-solids concentration of 200 mg/ℓ.

b. Default data are given below:

BOD LOADING	90.0 LB/ACRE/DAY
DEPTH	3.0 FEET
AEROBIC LAGOON	

c. Lagoon unit process data cards are listed below:

LAGOON MOD xx.x

BOD LOADING RATE xx.x LB/ACRE/DAY

DEPTH OF LAGOON xx.x FEET

LINER REQUIRED[a,b] UPILL xx.x $/SQ FT RSLL = xx.x YEARS

AEROBIC LAGOON[c]

FACULTATIVE LAGOON[c]

ANAEROBIC LAGOON[c]

ESTIMATE[d] COSTSP = xx.x COSTSV = xx.x

REPLACEMENT[b] RSSP = xx.x RSSV = xx.x RSST = xx.x YEARS

END

---

[a] If no liner card is input, lagoon will be unlined. UPILL = cost of installed liner in $/sq ft; default value = unlined.

[b] RSLL = Service life of liner. See Appendix F.

[c] Use only one of aerobic, facultative, or anaerobic; default value = aerobic.

[d] COSTSP = Cost of 12-in.-diam welded steel pipe; default value = $12.80/ft. COSTSV = Cost of 12-in.-diam butterfly valve; default value = $952.10/value.

4-16. Overland Flow Land Treatment.

a. Design parameters for overland flow land treatment are listed below:

Application rate = 2.5-6.0 in./wk (screened wastewater)

Application rate = 6.0-16.0 in./wk (lagoon or secondary effluent)

Desired nitrate percolate = 0.1-10.0 mg/ℓ

Desired BOD percolate = 0.1-30.0 mg/ℓ

Runoff (site dependent) = 0.0 in./wk

Spray evaporation (percent of application rate) = 2.0-8.0%

Percolate of soil (percent of application rate) = 2.0-8.0%

Buffer zone (site dependent) = 0.0-500.0 ft

Slope = 2.0-8.0% (over 8.0% requires finished slopes)

Fraction of nitrogen loading denitrified = 75.0-90.0% (percent of total applied N)

Ammonia volatilization = 0.0 (percent of total applied N)

b. Default data are given below:

```
FORAGE GRASSES                              0.0   $/ACRE
APPLICATION RATE (HYDRAULIC)                3.5   IN/WEEK
DESIRED EFFLUENT (MAXIMUM)  NITRATE        10.0  MG/L
PRECIPITATION RATE                          0.8   IN/WEEK
EVAPOTRANSPIRATION RATE                     0.4   IN/WEEK
WASTEWATER GENERATION PERIOD              365.0   DAYS/YR
FIELD APPLICATION PERIOD                   52.0   WEEKS/YR
SPRAY EVAPORATION RATE                      5.0   PERCENT
PERCOLATE RATE OF SOIL                      5.0   PERCENT
STORAGE REQUIRED                           30.0   DAYS/YEAR
OPEN CHANNEL RECOVERY SYSTEM
BUFFER ZONE                                 0.0   FEET
CURRENT GROUND COVER    FOREST   20.0 %  BRUSH 30.0 %  PASTURE 50.0%
SLOPE                                       2.0   PERCENT
MONITORING WELLS                          5 WELLS AT 10 FT/WELL
FENCING                                    2.75   $/FT
FRACTION DENITRIFIED                       90.0   PERCENT OF APPLIED N
AMMONIA VOLATILIZATION                      0.0   PERCENT OF APPLIED N
DAYS PER WEEK OPERATION                     7.0   DAYS/WEEK
HOURS PER DAY OPERATION                     6.0   HOURS/DAY
```

c. Overland flow land treatment unit process data cards are listed below:

OVERLAND FLOW LAND TREATMENT MOD xx

APPLICATION RATE	xx.x	IN/WK
DESIRED EFFLUENT (MAXIMUM) NITRATE	xx.x	MG/L
PRECIPITATION RATE	xx.x	IN/WK
EVAPOTRANSPIRATION RATE	xx.x	IN/WK
WASTEWATER GENERATION PERIOD	xx.x	DAYS/YR
FIELD APPLICATION PERIOD	xx.x	WEEKS/YR
SPRAY EVAPORATION	xx.x	PERCENT
PERCOLATE OF SOIL	xx.x	PERCENT
STORAGE REQUIRED	xx.x	DAYS/YR

LINER REQUIRED[a,b] UPILL = xx.x $/SQ FT RSLL = xx.x YEARS

EMBANKMENT PROTECTION[a,b] CSBA = xx.x $/CU YD RSBA = xx.x YEARS

GRAVITY PIPE RECOVERY SYSTEM[c]

OPEN CHANNEL RECOVERY SYSTEM[c]

BUFFER ZONE WIDTH xx.x FT

CURRENT GROUND COVER FORESTG = xx.x% BRUSH = xx.x%
PASTURE = xx.x%

SLOPE OF LAND xx.x PERCENT

MONITORING WELLS NO = xx.x DEPTH/WELL = xx.x FT

FENCING	xx.x	$/FT
FRACTION DENITRIFIED	xx.x	PERCENT
AMMONIA VOLATILIZATION	xx.x	PERCENT
HOURS PER DAY OPERATION	xx.x	HOURS
DAYS PER WEEK OPERATION	xx.x	DAYS

FORAGE REVENUE = xx.x $/ACRE/YEAR

ESTIMATE[d] PS = xx.x SP = xx.x SV = xx.x CS = xx.x
CG = xx.x MW = xx.x SC = xx.x

REPLACEMENT[d] RSPS = xx.x RSSP = xx.x RSSV = xx.x
RSCS = xx.x RSMW = xx.x RSSC = xx.x RSST = xx.x YEARS

END

---

[a] UPILL = cost of installed liner; RSLL = liner life; CSBA = cost of embankment protection; RSBA = life of embankment protection.

[b] See Appendix F.

[c] Use gravity pipe or open channel, not both; default value = open channel.

[d] PS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250. SP = Cost of 12-in. welded steel pipe, in place; default value = $12.80/ft. SV = Cost of 12-in. butterfly valve; default value = $952.10. CS = Cost of 6- to 15-gpm impact-type full circle sprinkler; default value = $61.65. CG = Cost of clearing and grubbing; default value = $3,000/acre (assumed for heavy clearing and grubbing). MW = Cost of 4-in. water well; default value = $8.00/ft. SC = Cost of 24-in. reinforced concrete drainpipe; default value = $10.20/ft.

4-17. Oxidation Ditches.

a. Design parameters for oxidation ditches are listed below:

Organic loading rate (F/M ratio) = 0.067 lb BOD/lb MLVSS/day

Volumetric loading = 12.5 lb BOD/1000 cu ft/day

Recycle ratio = 50.0-100.0%

Oxygen required = 2.35 lb O_2/lb BOD removed

Wasted sludge = 0.68 lb/lb BOD removed

b. Default data are given below:

```
F/M RATIO                              0.067 LB BOD/LB MLVSS/DAY
VOLUMETRIC LOADING                     12.5 LB BOD/T CFT/DAY
RECYCLE RATIO                          100.0 PERCENT
WASTED SLUDGE                          0.68 LB/LB BOD
OXYGEN REQUIRED                        2.35 LB O/LB BOD
REMOVAL  SS= 90.0 BOD= 90.0 TKN= 60.0 PO= 30.0
```

c. Oxidation ditch unit process data cards are listed below:

OXIDATION DITCH[a] MOD xx.x

F/M RATIO xx.x LB BOD/LB MLVSS/DAY

VOLUMETRIC LOADING xx.x LB BOD/T CU FT/DAY

RECYCLE RATIO xx.x PERCENT

WASTED SLUDGE xx.x LB/LB BOD REMOVED

OXYGEN REQUIRED xx.x LB O_2/LB BOD

REMOVAL RATES SS = xx.x BOD = xx.x TKN = xx.x
PO = xx.x PERCENT

ESTIMATE[b] COSTDS = xx.x COSTPS = xx.x

REPLACEMENT[c] RSDS = xx.x RSPS = xx.x RSST = xx.x YEARS

END

---

[a] User must also specify secondary clarification (oxidation ditch).

[b] COSTDS = Cost of a standard 42-in.-diam and 20-ft-long brush aerator; default value = $15,340. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.00.

[c] See Appendix F.

4-18. Postaeration.

a. Design parameters for postaeration are listed below:

Detention time = 5-15 min

Pressure correction factor = 1.0

Additional parameters include:

Parameter	Suggested Values
ALPHA	O_2 transfer in waste/O_2 transfer in water = 0.90
BETA	O_2 saturation in waste/O_2 saturation in water = 0.90
N	Water quality parameter for cascade aeration = 0.80
M	Weir geometry parameter Step = 1.30 Free = 1.00
STE	Standard transfer efficiency Mechanical aerators = 2.0-3.5 lb O_2/hp-hr High speed = 2.0 Slow speed = 3.5 Diffused aerator = 6.0-11.0% Coarse bubble = 6.0 Fine bubble = 11.0

b. Default data are given below:

```
DIFFUSED AERATION ALPHA=0.9 BETA=0.9   STE=6  PERCENT
DETENTION TIME                 10          MIN
DISSOLVED OXYGEN      INITIAL=2.0   FINAL=5.0     MG/L
CORRECTION FOR PRESSURE        1.0
SUMMER TEMPERATURE             25 DEG C
MINIMUM DISSOLVED OXYGEN       2.0 MG/L
```

c. Postaeration unit process data cards are listed below:

POSTAERATION MOD xx

DISSOLVED OXYGEN INFLUENT = xx.x EFFLUENT = xx.x MG/L

DETENTION TIME xx.x MINUTES

CORRECTION FOR PRESSURE xx.x

SUMMER TEMPERATURE xx.x DEG C

MINIMUM DISSOLVED OXYGEN xx.x MG/L

MECHANICAL AERATION[a] ALPHA = xx.x BETA = xx.x
STE = xx.x LB O/HPR-HR

DIFFUSED AERATION[a] ALPHA = xx.x BETA = xx.x
STE = xx.x PERCENT

STEP CASCADE AERATION[a] N[b] = xx.x M[c] = xx.x

FREE CASCADE AERATION[a] N[b] = xx.x M[c] = xx.x

ESTIMATE[d] COSTSA = xx.x COSTPD = xx.x COSTPH = xx.x

REPLACEMENT[e] RSSA = xx.x RSPD = xx.x RSPH = xx.x
RSST = xx.x YEARS

END

---

[a] Use mechanical, diffused, step, or free aeration, but not more than one; default value = diffused.

[b] N is the water quality parameter for wastewater treatment plant effluent; default value = 0.80.

[c] M is the weir geometry parameter; default value = 1.0 for free aeration and 1.30 for step aeration.

[d] COSTSA = Cost of standard 50-hp high-speed floating aerator; default value = $13,960. COSTPD = Cost of standard 12-scfm coarse-bubble diffuser; default value = $6.50. COSTPH = Cost of standard 550-scfm swing arm diffuser; default value = $5,000.

[e] See Appendix F.

4-19. Primary Clarification.

a. Design parameters for primary clarification are listed below:

Sidewater depth = 7.0-12.0 ft
Underflow concentration of solids = 4.0-6.0%
Weir overflow rate = 10,000-15,000 gal/day/ft
Surface overflow rate (see Table 4-2)
Specific gravity of sludge (see Table 4-3)
Suspended solids removal (see Figure 4-1)
BOD removal (see Figure 4-2)

Table 4-2. Recommended Surface Loading Rates for Various Suspensions[a]

Suspension	Loading Rate, gpd/ft^2 Range	Loading Rate, gpd/ft^2 Peak Flow
Untreated wastewater	600 to 1200	1200
Alum floc[b]	360 to 600	600
Iron floc[b]	540 to 800	800
Lime floc[b]	540 to 1200	1200

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering; Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972 by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

[b] Mixed with the settleable suspended solids in the untreated wastewater and colloidal or other suspended solids swept out by the floc.

Table 4-3. Specific Gravity of Raw Sludge Produced from Various Types of Sewage[a]

Type of Sewerage System	Strength of Sewage	Specific Gravity
Sanitary	Weak	1.02
Sanitary	Medium	1.03
Combined	Medium	1.05
Combined	Strong	1.07

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering; Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972 by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

b. Default data are given below:

```
CIRCULAR CLARIFIER
SURFACE OVERFLOW RATE                     1000       G/D/SQFT
SIDE WATER DEPTH                          9          FEET
SPECIFIC GRAVITY                          1.05
UNDERFLOW CONCENTRATION                   4          PERCENT
REMOVAL     SOLIDS=58     BOD=32          COD=40     TKN=5     PO=5   PERCENT
WEIR OVERFLOW RATE                        15000      G/D/FT
```

c. Primary clarification unit process data cards are listed below:

```
PRIMARY CLARIFICATION                                MOD xx

SURFACE OVERFLOW RATE                                xx.x       G/D/SQ FT

SIDEWATER DEPTH                                      xx.x       FT

SPECIFIC GRAVITY                                     xx.x

UNDERFLOW CONCENTRATION                              xx.x       PERCENT

REMOVAL[a]  SOLIDS = xx.x   BOD = xx.x   COD = xx.x
  TKN = xx.x  PO = xx.x                                         PERCENT

WEIR OVERFLOW RATE                                   xx.x       G/D/FT

RECTANGULAR CLARIFIER[b]

CIRCULAR CLARIFIER[b]

ESTIMATE[c]  STANDARD MECHANISM COST = xx.x

REPLACEMENT[d]     RSSM = xx.x   RSST = xx.x                    YEARS

END
```

---

[a] Specify total removals.

[b] Use rectangular or circular clarifier, not both; default value = circular clarifier.

[c] Rectangular clarifier--cost of standard 20- by 120-ft clarifier mechanism; default value = $42,000. Circular clarifier--cost of standard 90-ft-diam clarifier mechanism; default value = $75,000.

[d] See Appendix F.

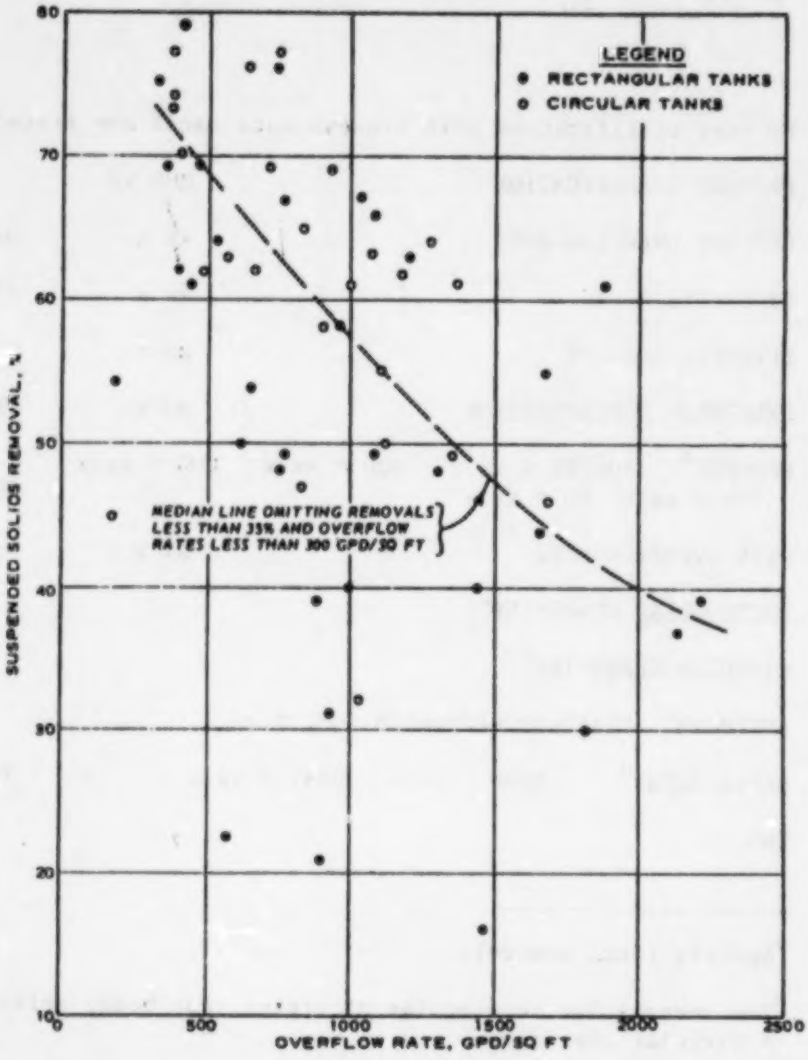

Figure 4-1. Suspended solids removal versus overflow rate for primary clarifiers (courtesy of American Society of Civil Engineers and the Water Pollution Control Federation 1977)

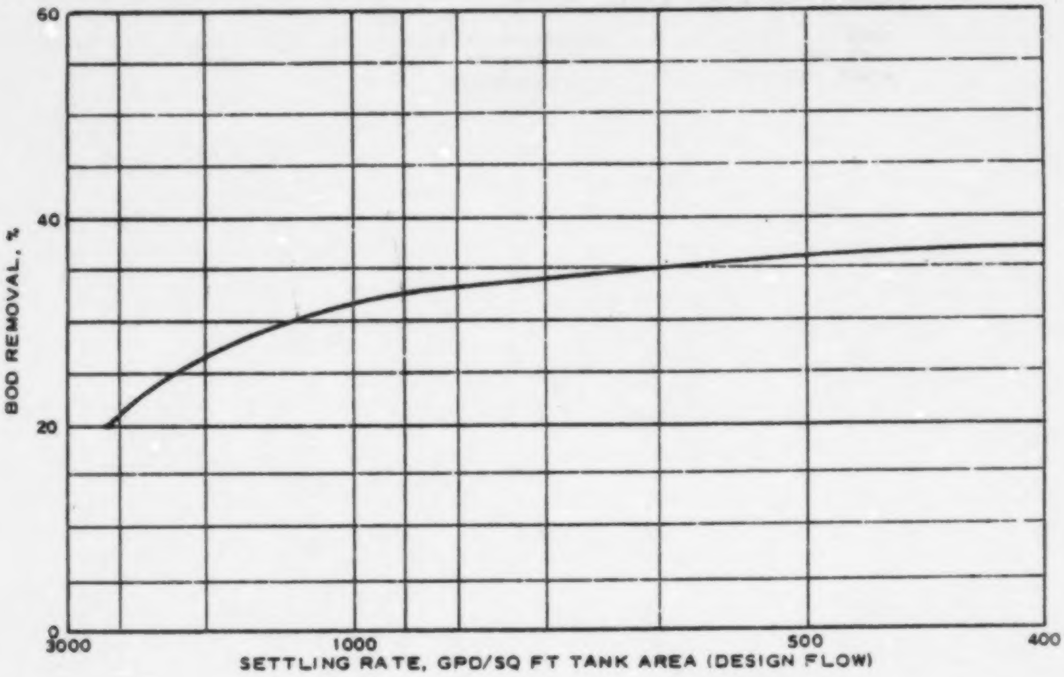

Figure 4-2. BOD removal rate in primary clarifier
(prepared by WES)

4-20. Pumping.

a. Design parameters for pumping are listed below:

Flow should be specified as a percent of the average flow.

b. Default data are given below:

```
FLOW                      100.00 PERCENT
DAYS PER WEEK               7.00 DAYS
HOURS PER DAY              24.00 HOURS
```

c. Pumping unit process data cards are listed below:

```
PUMP[a]                                MOD  xx.x
FLOW                                        xx.x     PERCENT
DAYS PER WEEK                               xx.x     DAYS
HOURS PER DAY                               xx.x     HOURS
ESTIMATE[b]      COSTPS = xx.x
REPLACEMENT[c]     RSPS = xx.x   RSST = xx.x         YEARS
END
```

---

[a] This process is included automatically by some treatment processes. These processes may be identified by the presence of COSTPS on the ESTIMATE card of the unit process input data cards.

[b] COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

[c] See Appendix F.

4-21. Rapid Infiltration Land Treatment.

a. Design parameters for rapid infiltration land treatment are listed below:

Application rate = 4.0-150.0 in./wk

Buffer zone (site dependent) = 0.0-500.0 ft

Fraction of nitrogen loading denitrified = 30.0-60.0%
(percent of total applied N)

Ammonia volatilization = 0.0% (percent of total applied N)

b. Default data are given below:

```
APPLICATION RATE                        15.0   IN/WEEK
PRECIPITATION RATE                       0.8   IN/WEEK
EVAPOTRANSPIRATION RATE                  0.4   IN/WEEK
WASTEWATER GENERATION PERIOD           365.0   DAYS/YR
NO RECOVERY SYSTEM
BUFFER ZONE                              0.0   FEET
MONITORING WELLS                     9 WELLS AT 10 FT/WELL
FENCING                                 2.75   $/FT
FRACTION DENITRIFIED                    45.0   PERCENT OF APPLIED N
AMMONIA VOLATILIZATION                   0.0   PERCENT OF APPLIED N
```

c. Rapid infiltration land treatment unit process data cards are listed below:

RAPID INFILTRATION LAND TREATMENT MOD xx

APPLICATION RATE xx.x IN/WK

PRECIPITATION RATE xx.x IN/WK

EVAPOTRANSPIRATION RATE xx.x IN/WK

WASTEWATER GENERATION PERIOD xx.x DAYS/YR

NO RECOVERY SYSTEM[a]

UNDERDRAIN RECOVERY SYSTEM[a]

RECOVERY WELLS SYSTEM[a,b] NW = xx.x WDIA = xx.x IN
DW = xx.x FT

BUFFER WIDTH xx.x FT

MONITORING WELLS NO = xx.x DEPTH/WELL = xx.x FT
FENCING[c,d] CSFN = xx.x $/FT RSFN = xx.x YEARS
FRACTION DENITRIFIED xx.x PERCENT

AMMONIA VOLATILIZATION xx.x PERCENT

ESTIMATE[e] SP = xx.x BV = xx.x PP = xx.x CP = xx.x WW = xx.x

REPLACEMENT[d] RSSP = xx.x RSBV = xx.x RSPP = xx.x RSCP = xx.x
RSMW = xx.x RSRW = xx.x RSPS = xx.x RSST = xx.x YEARS

END

---

[a] Use recovery wells, underdrains, or no recovery system, but no more than one; default value = no recovery system.

[b] NW = Number of recovery wells. WDIA = Diameter of recovery wells. DW = Depth of recovery wells.

[c] CSFN = Cost of fencing; RSFN = Service life of fence.

[d] See Appendix F.

[e] SP = Cost of 12-in. welded steel pipe, in place; default value = $12.80/ft. BV = Cost of 12-in. butterfly valve; default value = $952.10. PP = Cost of 6-in. perforated PVC pipe; default value = $6.94/ft. CP = Cost of 24-in. concrete Class III pipe; default value = $10.20/ft. WW = Cost of 4-in. water well; default value = $8.00/ft. PS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

4-22. **Raw Sewage Pumping.**

a. Design parameters for raw sewage pumping are listed below:

Pump head = 40.0 ft

b. Default data are given below:

```
STATIC HEAD                             40.0 FEET
```

c. Raw sewage pumping unit process data cards are listed below:

RAW SEWAGE PUMPING MOD xx

HEAD xx.x FT

ESTIMATE[a] COSTPS = xx.x

REPLACEMENT[b] RSPS = xx.x RSST = xx.x YEARS

END

---

[a] COSTPS = Cost of a standard pump and driver unit capable of pumping 100 gpm at 40 ft; default value = $2,800.

[b] See Appendix F.

4-23. Secondary Clarification (Oxidation Ditch).

a. Design parameters for secondary clarification (oxidation ditch) are listed below:

Solids loading rate = 12.0-30.0 lb/sq ft/day

Surface overflow rate (small plants ≤ 1.0 mgd) ≤ 600 gal/sq ft/day

Surface overflow rate (large plants ≥ 1.0 mgd) ≤ 800 gal/sq ft/day

Underflow concentration = 0.8-1.2%

Weir overflow rate = 10,000-15,000 gal/ft/day

Sidewater depth = 7.0-12.0 ft

Specific gravity of sludge (see Table 4-4)

Table 4-4. Specific Gravity of Raw Sludge Produced from Various Types of Sewage[a]

Type of Sewerage System	Strength of Sewage	Specific Gravity
Sanitary	Weak	1.02
Sanitary	Medium	1.03
Combined	Medium	1.05
Combined	Strong	1.07

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering; Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972 by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

b. Default data are given below:

```
CIRCULAR
SOLID LOADING RATE (MAXIMUM)        20        LB/SQFT/DAY
SURFACE OVERFLOW RATE               500       G/SQFT/DAY
SPECIFIC GRAVITY OF SLUDGE          1.03
UNDERFLOW CONCENTRATION             1.0       PERCENT
WEIR OVERFLOW RATE (MAXIMUM)        15000     G/D/FT
SIDE WATER DEPTH                    9         FEET
EFFLUENT SUSPENDED SOLIDS           20        MG/L
```

c. Secondary clarification (oxidation ditch)[a] unit process data cards are listed below:

```
O SECONDARY CLARIFICATION (OXIDATION DITCH)    MOD  xx

SOLID LOADING RATE (MAXIMUM)              xx.x     LB/SQ FT/DAY

SURFACE OVERFLOW RATE                     xx.x     G/SQ FT/DAY

SPECIFIC GRAVITY OF SLUDGE                xx.x

UNDERFLOW CONCENTRATION                   xx.x     PERCENT

WEIR OVERFLOW RATE                        xx.x     G/FT/DAY

SIDEWATER DEPTH                           xx.x     FT

EFFLUENT SUSPENDED SOLIDS                 xx.x     MG/L

RECTANGULAR CLARIFIER[b]

CIRCULAR CLARIFIER[b]

ESTIMATE[c]  STANDARD MECHANISM COST = xx.x

REPLACEMENT[d]    RSMS = xx.x    RSST = xx.x       YEARS

END
```

---

[a] This process is used with the oxidation ditch process.

[b] Use rectangular or circular clarifier, not both; default value = circular clarifier.

[c] Rectangular clarifier--cost of standard 20- by 120-ft clarifier mechanism; default value = $42,000. Circular clarifier--cost of standard 90-ft-diam clarifier mechanism; default value = $75,000.

[d] See Appendix F.

4-24. Secondary Clarification (Trickling Filters).

a. Design parameters for secondary clarification (trickling filters) are listed below:

Solids loading rate = 12.0-30.0 lb/sq ft/day

Surface overflow rate (small plants ≤ 1.0 mgd) ≤ 600 gal/sq ft/day

Surface overflow rate (large plants ≥ 1.0 mgd) ≤ 800 gal/sq ft/day

Underflow concentration = 2.0-4.0%

Weir overflow rate = 10,000-15,000 gal/ft/day

Sidewater depth = 7.0-12.0 ft

Mixed liquor volatile solids = 1000-2500 mg/ℓ

Specific gravity of sludge (see Table 4-5)

Table 4-5. Specific Gravity of Raw Sludge Produced from Various Types of Sewage[a]

Type of Sewerage System	Strength of Sewage	Specific Gravity
Sanitary	Weak	1.02
Sanitary	Medium	1.03
Combined	Medium	1.05
Combined	Strong	1.07

[a] Prepared by Metcalf and Eddy (1972). From Wastewater Engineering; Collection, Treatment, and Disposal by Metcalf and Eddy, Inc. Copyright © 1972 by McGraw-Hill, Inc. Used with the permission of McGraw-Hill Book Company.

b. Default data are given below:

```
CIRCULAR
SOLID LOADING RATE (MAXIMUM)       20       LB/SQFT/DAY
SURFACE OVERFLOW RATE              800      G/SQFT/DAY
SPECIFIC GRAVITY OF SLUDGE         1.03
UNDERFLOW CONCENTRATION            3.0      PERCENT
WEIR OVERFLOW RATE (MAXIMUM)       15000    G/D/FT
SIDE WATER DEPTH                   9        FEET
EFFLUENT SUSPENDED SOLIDS          40       MG/L
FILTER UNDERFLOW SOLIDS            100      MG/L
```

c. Secondary clarification (trickling filters) unit process data cards are listed below:

T SECONDARY CLARIFICATION (TRICKLING FILTERS)[a]		MOD xx
SOLID LOADING RATE (MAXIMUM)	xx.x	LB/SQ FT/DAY
SURFACE OVERFLOW RATE	xx.x	G/SQ FT/DAY
SPECIFIC GRAVITY OF SLUDGE	xx.x	
UNDERFLOW CONCENTRATION	xx.x	PERCENT
WEIR OVERFLOW RATE (MAXIMUM)	xx.x	G/FT/DAY
SIDEWATER DEPTH	xx.x	FT
EFFLUENT SUSPENDED SOLIDS	xx.x	MG/L
FILTER UNDERFLOW SOLIDS	xx.x	MG/L
MIXED LIQUOR VS	xx.x	MG/L
RECTANGULAR CLARIFIER[b]		
CIRCULAR CLARIFIER[b]		
ESTIMATE[c] STANDARD MECHANISM COST = xx.x		
REPLACEMENT[d] RSMS = xx.x RSST = xx.x		YEARS
END		

---

[a] This process is part of the trickling filtration process.

[b] Use rectangular or circular clarifier, not both; default value = circular clarifier.

[c] Rectangular clarifier--cost of standard 20- by 120-ft clarifier mechanism; default value = $42,000. Circular clarifier--cost of standard 90-ft-diam clarifier mechanism; default value = $75,000.

[d] See Appendix F.

4-25. Septic Tanks and Tile Fields.

a. Design parameters for septic tanks and tile fields are listed below:

Percolation rate (site specific) = 0.50 min/in.

b. Default data are given below:

PERCOLATION RATE	0.5 MIN/INCH

c. Septic tank and tile field unit process data cards are listed below:

```
SEPTIC TANK                               MOD     xx

PERCOLATION RATE                                  xx.x          MIN/IN

ESTIMATE[a]   COSTCP = xx.x   COGRVL = xx.x

REPLACEMENT[b]  RSCP = xx.x   RSST = xx.x                       YEARS

END
```

---

[a] COSTCP = Cost of installed 6-in. perforated clay pipe; default value = \$2.75/ft. COGRVL = Cost of gravel; default value = \$4.30/cu yd.

[b] See Appendix F.

4-26. Slow Infiltration Land Treatment.

a. Design parameters for slow infiltration land treatment are listed below:

Average application rate = 0.5-4.0 in./wk

Maximum application rate = 0.10-0.50 in./hr

Desired nitrate percolate = 0.10-10.0 mg/ℓ

Runoff (site dependent) = 0.0 (should be specified 0.0 as runoff is generally negligible)

Buffer zone (site dependent) = 0.0-500.0 ft

Fraction of nitrogen loading denitrified = 15.0-25.0% (percent of total applied N)

Ammonia volatilization = 0.0% (percent of total applied N)

Removal of phosphorus = 80.0%

Slope on cultivated land ≤ 20.0%

Slope on noncultivated land ≤ 40.0%

b. Default data are given below:

```
FORAGE GRASSES                               0.0   $/ACRE
APPLICATION RATE (HYDRAULIC) AVERAGE      2.0 IN/WEEK   MAXIMUM  0.20 IN/HR
PRECIPITATION RATE                           0.8   IN/WEEK
DESIRED NITRATE PERCOLATE (MAX)             10.0   MG/L
EVAPOTRANSPIRATION RATE                      0.4   IN/WEEK
RUNOFF                                       0.0   IN/WEEK
WASTEWATER GENERATION PERIOD               365.0   DAYS/YR
FIELD APPLICATION PERIOD                    52.0   WEEKS/YR
SOLID SET PIPING AND PUMPING
STORAGE REQUIRED                            70.0   DAYS
NO RECOVERY SYSTEM
BUFFER ZONE                                  0.0   FEET
CURRENT GROUND COVER   FOREST  20.0 %  BRUSH 30.0 %  PASTURE 50.0%
SLOPE                                        2.0   PERCENT
MONITORING WELLS                           9 WELLS AT 10 FT/WELL
FENCING                                     2.75   $/FT
FRACTION DENITRIFIED                        20.0   PERCENT OF APPLIED N
AMMONIA VOLATILIZATION                       0.0   PERCENT OF APPLIED N
REMOVAL OF PHOSPHORUS                       80.0   PERCENT OF APPLIED P
DAYS PER WEEK OPERATION                      7.0   DAYS/WEEK
HOURS PER DAY OPERATION                      8.0   HOURS/DAY
```

c. Slow infiltration land treatment unit process data cards are listed below:

SLOW INFILTRATION LAND TREATMENT MOD xx

FORAGE GRASSES[a] REVENUE = xx.x $/ACRE/YEAR

CORN[a] REVENUE = xx.x $/ACRE/YEAR

APPLICATION RATE AVERAGE = xx.x IN/WEEK
MAXIMUM = xx.x IN/HR

DESIRED NITRATE PERCOLATE (MAXIMUM) xx.x MG/L

PRECIPITATION RATE xx.x IN/WK

EVAPOTRANSPIRATION RATE xx.x IN/WK

RUNOFF xx.x IN/WK

WASTEWATER GENERATION PERIOD xx.x DAYS/YR

FIELD APPLICATION PERIOD xx.x WEEKS/YR

SOLID SET PIPING[b]

CENTER PIVOT PIPING[b]

STORAGE REQUIRED[c] xx.x DAYS/YR

LINER REQUIRED[c] UPILL = xx.x $/SQ FT RSLL = xx.x YEARS

EMBANKMENT PROTECTION[c] CSBA = xx.x $/CU YD RSBA = xx.x YEARS

NO RECOVERY SYSTEM[d]

UNDERDRAIN RECOVERY SYSTEM[d]

(Continued)

---

[a] Use corn or forage grasses, not both; default value = forage grasses.

[b] Use solid set or center pivot, not both; default value = solid set.

[c] Liner or embankment protection should only be used with storage. UPILL = Cost of installed liner; RSLL = Service of life of liner; CSBA = Cost of embankment protection; RSBA = embankment protection service liner.

[d] Use no recovery system or underdrains, not both; default value = no recovery system.

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BUFFER WIDTH xx.x FT

CURRENT GROUND COVER FOREST = xx.x% BRUSH = xx.x%
PASTURE = xx.x%

SLOPE xx.x PERCENT

MONITORING WELLS NO = xx.x DEPTH/WELL = xx.x FT

FENCING[e,f] COSFN = xx.x $/FT RSFN = xx.x YEARS

FRACTION DENITRIFIED xx.x PERCENT

AMMONIA VOLATILIZATION xx.x PERCENT

REMOVAL OF PHOSPHORUS xx.x PERCENT

HOURS PER DAY OPERATION xx.x HOURS

DAYS PER WEEK OPERATION xx.x DAYS

ESTIMATE[e] PS = xx.x SP = xx.x SV = xx.x EN = xx.x
CG = xx.x MW = xx.x PC = xx.x PP = xx.x

REPLACEMENT[f] RSPS = xx.x RSSP = xx.x RSSV = xx.x RSEN = xx.x
RSMW = xx.x RSPC = xx.x RSPP = xx.x RSST = xx.x YEARS

END

---

[e] PS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250. SP = Cost of 12-in. welded steel pipe, in place; default value = $12.80/ft. SV = Cost of 12-in. butterfly valve; default value = $952.10. EN = Cost of 6- to 15-gpm impact-type full circle sprinkler; default value = $61.65. CG = Cost of clearing and grubbing; default value = $3,000/acre (assumed for heavy clearing and grubbing). MW = Cost of 4-in. water well; default value = $8.00/ft. PC = Cost of center pivot 100-acre sprinkler system; default value = $27,690. PP = Cost of 6-in. perforated PVC pipe; default value = $6.94/ft. COSFN = Cost of fencing in $/ft; default value = $2.75/ft.

[f] See Appendix F.

4-27. Sludge Drying Lagoons.

a. Design parameters for sludge drying lagoons are listed below:

Solids loading rate = 2.2-2.4 lb/yr/cu ft

Depth of sludge in lagoon = 1.0 ft

b. Default data are given below:

```
SOLIDS LOADING RATE           2.30 LB/YEAR/CUFT
DEPTH OF SLUDGE IN LAGOON     1.0 FEET
```

c. Sludge drying lagoon unit process data cards are listed below:

SLUDGE DRYING LAGOONS	MOD	xx	
SOLIDS LOADING RATE		xx.x	LB/YR/CU FT
DEPTH OF SLUDGE		xx.x	FT
ESTIMATE			
REPLACEMENT[a]	RSST =	xx.x	YEARS
END			

---

[a] See Appendix F.

4-28. <u>Trickling Filtration</u>.

a. Design parameters for trickling filtration are listed below:

Solid production rate = 0.42-0.65 lb solids/lb BOD_5 applied

Hydraulic loading rate = 0.75 gpm/sq ft

Specific surface

Surfpac	25-28 sq ft/cu ft

b. Default data are given below:

```
SOLID PRODUCTION RATE                0.45 LB/LB BOD
HYDRAULIC LOADING RATE               0.75 GPM/SQFT
SURFPAC                              26.0 SQFT/CUFT
EFFLUENT BOD                         30.0 MG/L
```

c. Trickling filter unit process data cards are listed below:

TRICKLING FILTER[a] MOD xx

EFFLUENT BOD xx.x MG/L

SOLID PRODUCTION RATE xx.x LB/LB BOD

HYDRAULIC LOADING xx.x GPM/SQ FT

SURFPAC SPECIFIC SURFACE xx.x SQ FT/CU FT

ESTIMATE[b] UPFM = xx.x CODAS = xx.x COSTPS = xx.x

REPLACEMENT[c] RSFM = xx.x RSAS = xx.x RSPS = xx.x
RSST = xx.x YEARS

END

---

[a] User should also specify secondary clarification (trickling filters).

[b] UPFM = Cost of selected media per cubic foot, installed; default value = $2.50/cu ft. CODAS = Cost of standard 50-ft-diam distributor arm; default value = $39,000. COSTPS = Cost of standard 3,000-gpm pump and driver unit; default value = $17,250.

[c] See Appendix F.

4-29. User-Specified Sludge Process.

a. In certain situations, the user may wish to adjust the sludge characteristics at some point within the treatment train. For these cases, the USER Specified sludge process is available. The USER Specified process is a sludge line process and is listed on the BLOCK card with the key word USER S. It may be used on either the primary or secondary sludge line. The user may specify a total reduction in the volume of sludge and the percent of volatile solids destroyed on the applicable sludge line. The cost data are user input and are of the same format as the cost override data.

b. User-specified sludge process data cards are listed below:

```
USER SPECIFIED SLUDGE PROCESS        MOD xx

VOLUME REDUCTION                                xx.x        PERCENT

PERCENT VS DESTROYED                            xx.x        PERCENT

COST    CAPITAL = xx.x    OPER MAN HRS = xx.x
  MAINT MAN HRS = xx.x    POWER COST = xx.x    SUPPLY COST = xx.x
  CHEMICAL COST = xx.x

REPLACEMENT[a]                       RSST = xx.x            YEARS

END
```

---

[a] RSST = Service life.

CHAPTER 5

UPGRADING AND EXPANSION
(Flow Control)

5-1. Introduction.

a. The CAPDET program is presented in Chapters 1 through 4 as originally conceived, designed, and developed for application to the cost estimating requirements associated with construction of new treatment plants. Under the new plant construction scenario, it is assumed that the various unit processes combined to form a treatment train may be temporally and spatially classified. Therefore, it was assumed that the total flow of wastewater entering the plant would be sequentially treated and eventually discharged. This "flow-through" concept of wastewater required little provision for the control of flow in the liquid and sludge lines. Although the DUMMY process could be used to control the flow to a limited extent, this procedure was somewhat cumbersome and difficult to implement.

b. A review of the 1978 Needs Survey (FRD-1) reveals that a substantial portion of wastewater treatment plant construction will be in the form of upgradings, expansions, and replacement. In order to improve the utility of the CAPDET model for application to the upgrading and expansion scenario, it becomes necessary to enhance the ability of the program user to control the flow between unit processes in a treatment train. This chapter describes modifications to the CAPDET program that allow the program user to control the temporal and spatial aspects of wastewater treatment. The program changes described herein do not alter any of the coding instructions outlined in the previous four chapters.

5-2. New Features.

a. Features have been added to the CAPDET program which allow the introduction of side streams at any point during liquid or sludge processing and the spatial and temporal control of flow. Both of these new features utilize a "storage in tanks" concept which allows the user to store an incoming side stream or a portion of the main line liquid or sludge flows being processed by the treatment train.

b. Ten liquid tanks and ten sludge tanks have been provided. These tanks are not true tanks in that they store or accumulate flows in millions of gallons per day rather than a total volume. The use of these pseudo tanks is for conceptual purposes only and the cost of the tanks is not included in plant cost estimates. In other words, the CAPDET tank is an imaginary liquid or sludge holding area or transfer station.

c. Tanks are numbered zero through nine. The coding for tanks is described below in Section 5-3 through 5-7.

5-3. Side Streams.

a. The entry of liquid and/or sludge side streams into the mainstream of the treatment plant processing scheme may be a common occurrence in regionalization or upgrading and expansion scenarios. In the CAPDET program, side stream flows and characteristics are specified and held in one of the tanks pending use during scheme execution. Sidestreams are specified at unit process specification time and are coded in the same manner as a unit process (paragraph 2-5).

b. The specification of a side stream begins with an L SIDE STREAM TANK NO. xx (S SIDE STREAM TANK NO. xx) header card and terminates with an END card.

c. The data cards used in the specification of a side stream consist of a key word in the first six columns of the card followed by the required numeric data in columns 7-80. The numeric data may be placed in any of the allowed columns but must be in the order shown for that particular card. No other numeric characters may be placed in columns 7-80. For purposes of this description, numeric characters are taken as the numerals 0-9, the minus sign (-), the plus sign (+), and the decimal point or period (.). Any other characters may be used in these columns to allow the user to identify the data items. Note, however, that the computer ignores these alphabetic descriptions and requires a specific order for the data on a card. The key word (columns 1-6) must appear exactly as shown on the card description.

d. A typical liquid side stream specification is illustrated below.

```
L SIDE STREAM                 TANK NO.  xxx
MINIMUM FLOW                            xx.x               MGD
AVERAGE FLOW         FINAL = xx.x  INITIAL = xx.x          MGD
MAXIMUM FLOW                            xx.x               MGD
TEMPERATURE         SUMMER = xx.x   WINTER = xx.x          DEG CENT
SUSPENDED SOLIDS                        xx.x               MG/L
VOLATILE SOLIDS                         xx.x               MG/L
SETTLEABLE SOLIDS                       xx.x               MG/L
BOD5                                    xx.x               MG/L
SBOD (SOLUBLE)                          xx.x               MG/L
COD                                     xx.x               MG/L
SCOD (SOLUBLE)                          xx.x               MG/L
PH
CATIONS                                 xx.x               MG/L
ANIONS                                  xx.x               MG/L
PO4                                     xx.x               MG/L
TKN                                     xx.x               MG/L
NH3                                     xx.x               MG/L
NO2                                     xx.x               MG/L
NO3                                     xx.x               MG/L
OIL AND GREASE                          xx.x               MG/L
END
```

e. A typical sludge side stream specification is illustrated below:

```
S SIDE STREAM                 TANK NO.  xxx
VOLUME                                 xx.x            GPM
SOLIDS                                 xx.x            PERCENT
PERCENT VOLATILE                       xx.x            PERCENT
END
```

f. Since ten liquid tanks and ten sludge tanks are available, ten liquid side streams and ten sludge side streams could be specified. If the tank number is omitted on the header card, tank number zero will be assumed.

5-4. Flow Control Functions.

a. Six flow control functions have been implemented in the CAPDET program. These functions will allow the CAPDET user to:

(1) Empty a tank and split a percentage of the flow in the line into that tank.

(2) Empty a tank and store 100 percent of the line flow into that tank.

(3) Mix a percentage of the line flow into a tank.

(4) Mix 100 percent of the line flow into a tank.

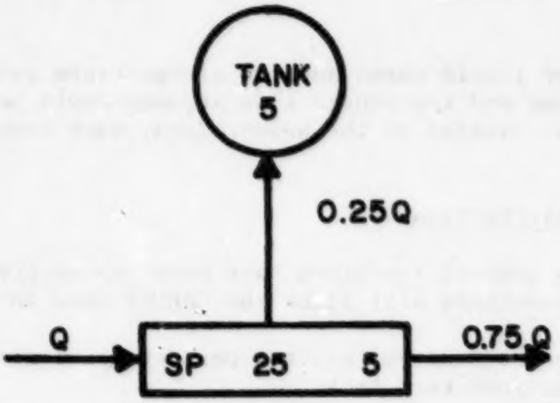
(5) Restart the line with the flow contained in a tank.

(6) Mix the flow contained in a tank into the line.

All six of these functions are available for the liquid line, the primary sludge line, and the secondary sludge line. Each function is discussed in detail below. Coding instructions are presented in paragraph 5-5 below.

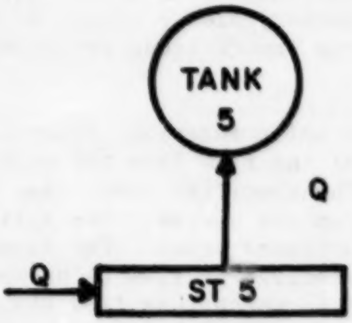
b. Split Function. The split function, denoted as SP, enables the user to remove a percentage of the flow from the main processing line and temporarily store it in the specified tank. Any previous contents of the tank are eliminated from the system. The split function, in block diagram format, is illustrated below. The first number following the SP designation is the percentage of flow to be split from the line. The second number is the tank to which this flow should be routed. It should be remembered that when the SP function is used, any flow previously accumulated in the specified tank will be lost from the system.

SP - SPLIT



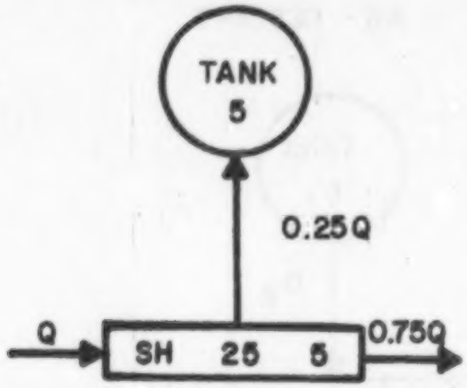
c. Store Function. The store function, denoted as ST, enables the user to replace the contents of the specified tank with the entire flow in the processing line, i.e. the ST function is equivalent to a 100 percent SP function. Any previous contents from the tank are eliminated from the system. Following use of the ST function, the processing line will contain 0 flow. The ST function, in block diagram format, is illustrated below.

ST - STORE



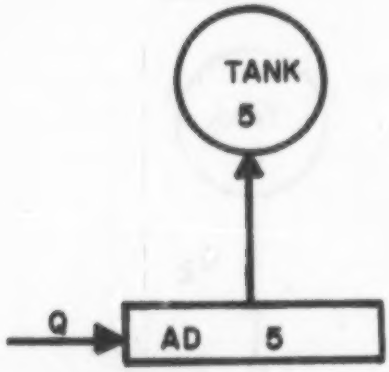
d. Shunt Function. The shunt function, denoted as SH, removes the specified percentage of the flow from the processing line and mixes and stores it with the contents of the specified tank. The characteristics of the combined flows are determined on a weighted average basis. The SH function, in block diagram format, is presented below.

SH - SHUNT



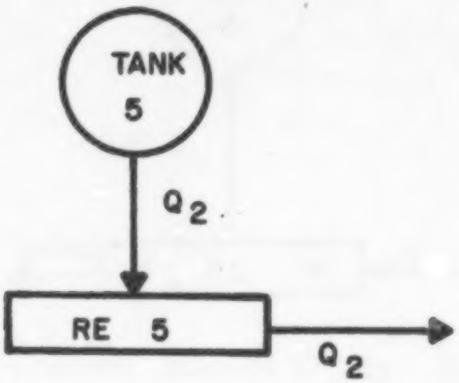
e. Add Function. The add function, denoted as AD, enables the user to mix the entire processing line flow with the contents of the specified tank, i.e. the AD function is equivalent to a 100 percent SH function. The mixed flows are stored in the specified tank to await further processing instruction. The characteristics of the mixed flows are determined on a weighted average basis. Following use of the AD function, the processing line will contain 0 flow. The AD function, in block diagram format, is presented below.

AD - ADD



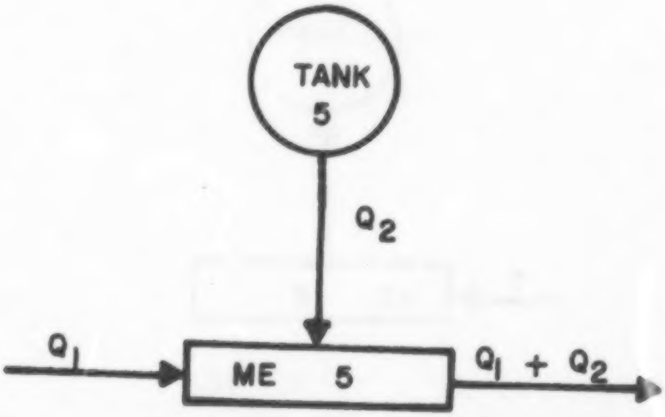
f. Restart Function. The restart function, denoted as RE, enables the user to replace the flow in the line with the flow from the specified tank. Subsequent processing on the line is based on the substituted flow value. The RE function, in block diagram format, is presented below.

RE - RESTART



g. Merge Function. The merge function, denoted as ME, enables the user to mix the contents of the specified tank into the processing line. Subsequent processing on the line is based on the combined flow with characteristics determined on a weighted average basis. The ME function, in block diagram format, is presented below.

ME-MERGE



5-5. Flow Control Function Coding.

a. The flow control functions are coded and used during scheme specification in place of BLOCK cards. The flow control function is entered as a single card entry consisting of a four-character keyword indicating the processing line prefix followed by the function designator and numeric data indicating flow removals, where appropriate, followed by tank specifications. Coding for the six functions is illustrated below. The action of the six functions was illustrated previously in paragraph 5-4.

Liquid Line	Primary Sludge Line	Secondary Sludge Line
L SP xx x	P SP xx x	S SP xx x
L ST x	P ST x	S ST x
L SH xx x	P SH xx x	S SH xx x
L AD x	P AD x	S AD x
L RE x	P RE x	S RE x
L ME x	P ME x	S ME x

where:
xx = percentage of the flow.
x = tank number.

b. A four-character keyword is used to identify the applicable line and function. The first character will be 'L,' 'P,' or 'S' indicating that the function is to be applied to the liquid, primary sludge, or secondary sludge line, respectively. The second character is a blank. Characters three and four specify the function. Numeric data required by the function are coded in the six columns or positions following the keyword. Where two items of numeric data are required, e.g. SP and SH function, a blank must be left between the percentage flow split data and the tank number specification. Numeric data must appear in proper order.

c. Any of the flow control functions (liquid, primary, or secondary) may be coded on the liquid line. This allows the user to store the accumulated sludges as processing occurs on the liquid line. For example, if the P ST function is used or the liquid line, only the primary sludges will be sent to the appropriate tank for storage. The liquid fraction and secondary sludges will be handled as per the discussion in paragraph 1-4. In an analagous manner, either primary or secondary sludge line functions may be used on the secondary sludge line. Only primary sludge functions are effective on the primary sludge line.

d. The model flexibility created by addition of the flow control functions makes the task of providing a comprehensive example using all flow control functions in one problem difficult. A typical example is presented in block diagram format in Figure 5-1. This scenario is described below in verbal form.

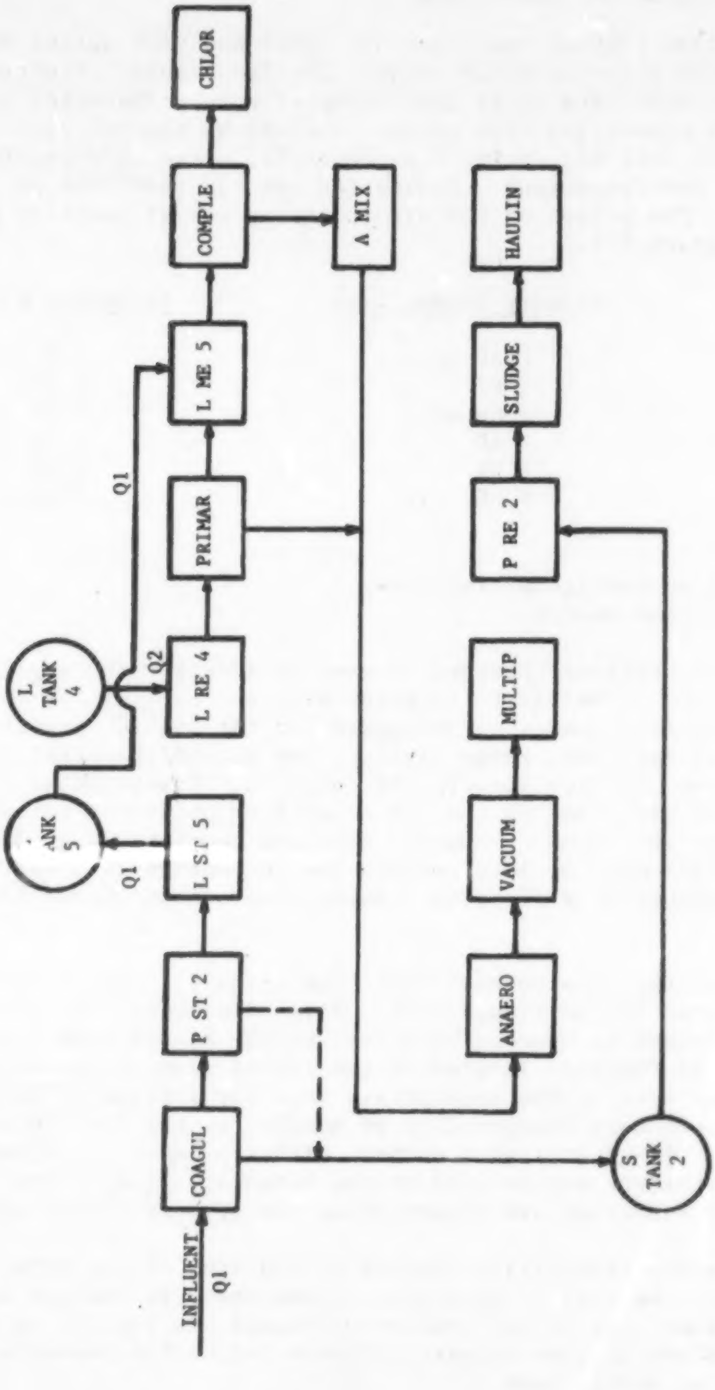

INFLUENT
Q1
COAGUL
P ST 2
L ST 5
Q1
TANK 5
L TANK 4
Q2
L RE 4
Q1
PRIMAR
L ME 5
COMPLE
CHLOR
A MIX
S TANK 2
ANAERO
VACUUM
MULTIP
P RE 2
SLUDGE
HAULIN

Figure 5-1. Schematic for an example problem

(1) A flow (Q_1) enters the treatment plant and is treated in a coagulation and sedimentation process. The primary sludges generated by this process are routed (P ST 2) to storage at tank location 2.

(2) The liquid and secondary sludge is routed (L ST 5) to storage at tank location 5.

(3) The liquid processing line is restarted (L RE 4) using a side stream flow from tank location 4. This flow (Q_2) is subjected to primary clarification. Subsequent to primary treatment the flow stored in tank location 5 (Q_1) is merged with Q_2 (L ME 5). This combined flow is then treated via a complete mix activated sludge system followed by chlorination.

(4) Secondary sludges from the complete mixed activated sludge process are combined (A MIX) with the primary sludges from the primary clarifier and treated by anaerobic digestion, vacuum filtration, and multiple hearth incineration.

(5) The primary sludge line is restarted (P RE 2) with the chemical coagulation sludges stored at tank location 2. These chemical sludges are treated by sludge lagooning followed by hauling and landfilling.

The coding necessary for running of the example is presented in Figure 5-2. Additional side stream and flow control example problems are presented in Appendix E.

```
L SIDE STREAM                    TANK 4
AVERAGE                          2          MGD
MAXIMUM                        3.5          MGD
BOD5                           200          MG/L
SBOD                           100          MG/L
TKN                             30          MG/L
COD                            300          MG/L
SCOD                           150          MG/L
TEMP                    20      10          DEG
PH                             7.0
PO4                             15          MG/L
END
TITLE EXAMPLE PROBLEM
LIQUID LINE
BLOCK     PRIMAR
P ST 2
L ST 5
L RE 4
BLOCK     PRIMAR
L ME 5
BLOCK     COMPLE
BLOCK     CHLORI
SECONDARY SLUDGE LINE
BLOCK     A MIX
PRIMARY SLUDGE LINE
BLOCK     ANAERO
BLOCK     DRYING
BLOCK     HAULIN
P RE 2
BLOCK     GRAVIT
BLOCK     MULTIP
WASTE INFLUENT AVERAGE  5     2.5
DESIRED EFFLUENT
UNIT COSTS
END
CONTROL CARDS
ANALYZE
GO                            7.125       30     3
```

Figure 5-2. Coding for the example problem

APPENDIX A

REFERENCES

American Society of Civil Engineers, "Sludge Treatment and Disposal by the Zimmerman Process," Journal, Sanitary Engineering Division, Vol 85, No. SA4, Part 1, July 1959, pp 13-23. Available from: Technical Information Center, U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Miss. 39180.

American Society of Civil Engineers and the Water Pollution Control Federation, "Wastewater Treatment Plan Design," Manual of Practice No. 8, 1977, Water Pollution Control Federation, 2626 Pennsylvania Ave. N.W., Washington, D. C. 20037. Available from: Environmental Laboratory, U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Miss. 39180.

Burd, R. S., "A Study of Sludge Handling and Disposal," Publication WP-20-4, May 1968, Federal Water Pollution Control Administration, U. S. Environmental Protection Agency, 401 M Street S.W., Washington, D. C. 20460. Available from: Technical Information Center, U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Miss. 39180.

Fair, G. M., Geyer, J. C., and Okun, D. A., Water Purification and Wastewater Treatment and Disposal; Water and Wastewater Engineering, Vol 2, 1968, John Wiley & Sons, 605 3rd Ave., New York, N. Y. 10016. Available from: Technical Information Center, U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Miss. 39180.

Metcalf and Eddy, Inc., Wastewater Engineering; Collection, Treatment, and Disposal, 1972, McGraw-Hill Book Company, 1221 Avenue of the Americas, New York, N. Y. 10020. Available from: Technical Information Center, U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Miss. 39180.

Simpson, G. D., "Operation of Vacuum Filters," Journal, Water Pollution Control Federation, Vol 36, Dec 1964, pp 1460-1467, 2626 Pennsylvania Ave. N.W., Washington D. C. 20037. Available from: Technical Information Center, U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Miss. 39180.

APPENDIX B

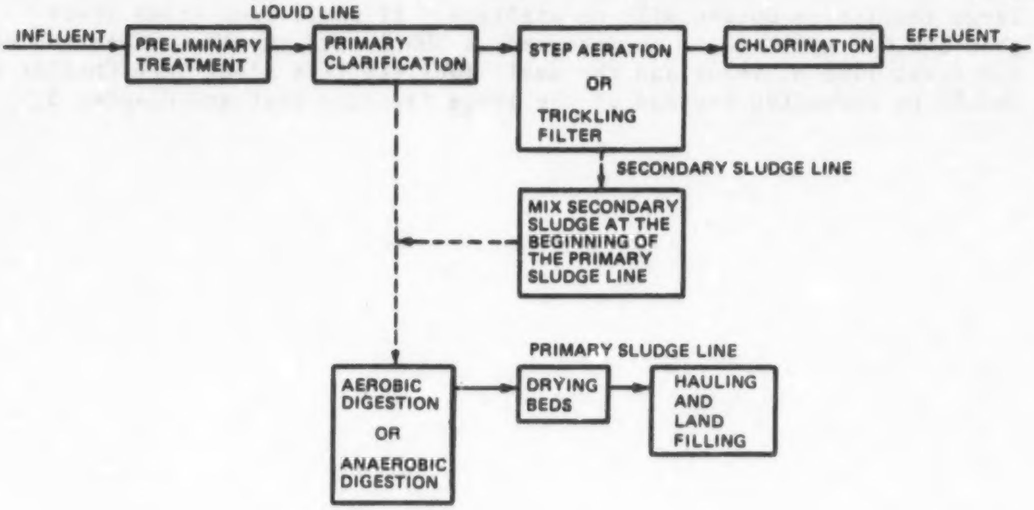
BASIC PROCEDURE FOR USING CAPDET

This section provides the user with a comprehensive outline of a recommended procedure for using the CAPDET program. The ten recommended steps are intended to illustrate to the user the logical sequence of events that will allow the user to accurately describe a proposed treatment scheme to the CAPDET program. This procedure assumes that the large facilities option will be utilized. If small facilities (less than 500,000 gpd) are to be designed, a SMALL card should be inserted as the first line of input and the small facility list along with Chapter 4 should be consulted instead of the large facility list and Chapter 3.

BASIC PROCEDURE FOR USING CAPDET

1. From the list beginning on page 2-11 select those treatment processes which are to be investigated. Make a sketch showing the treatment scheme, including in each treatment process block those options or alternatives to be used.

EXAMPLE:


LIQUID LINE
INFLUENT
PRELIMINARY TREATMENT
PRIMARY CLARIFICATION
STEP AERATION OR TRICKLING FILTER
CHLORINATION
EFFLUENT
SECONDARY SLUDGE LINE
MIX SECONDARY SLUDGE AT THE BEGINNING OF THE PRIMARY SLUDGE LINE
PRIMARY SLUDGE LINE
AEROBIC DIGESTION OR ANAEROBIC DIGESTION
DRYING BEDS
HAULING AND LAND FILLING

(Prepared by U. S. Army Engineer Waterways Experiment Station)

2. For each treatment process selected (see list beginning on page 2-11), list the unit process key words associated with the treatment processes and identify the unit process involved by referring to the list beginning on page 2-6.

EXAMPLE:

Treatment Process Key Word	Associated Unit Process Key Words	Unit Process Name
PRELIM	GRIT R	Grit removal
	SCREEN	Bar screens
	COMMIN	Comminution
PRIMAR	PRIMAR	Primary clarification
STEP A	STEP A	Step aeration
	A SECO	Secondary clarification (activated sludge)
TRICKL	TRICKL	Trickling filter
	T SECO	Secondary clarification (trickling filter)
CHLORI	CHLORI	Chlorination
A MIX	NONE	None
AEROBI	AEROBI	Aerobic digestion
ANAERO	ANAERO	Anaerobic digestion
DRYING	DRYING	Drying beds
HAULIN	HAULIN	Sludge hauling and land filling

3. In Chapter 3 review the default data supplied for the modifications of each of the unit processes selected in 2 above (see the table of contents for location of the unit process). For each process in which one wishes to change design parameters, a unit process header card for the process and data for those design parameters to be changed must be coded and input. Close the input for each process with an END card.

   a. Code the unit process key word in the first 6 columns.

   b. Code one line for each parameter to be changed. Code the first six letters and spaces of the parameter to be changed beginning in column 1 and the numeric data anywhere in columns 7 to 80. Use parameter names specified in the handbook.

   c. Code "END" beginning in column 1.

   d. Repeat for each unit process one wishes to modify.

   EXAMPLE: After examining the default data, it is desired to change the sidewater depth of the primary clarifier and the rainfall for drying beds. Code the following data:

```
PRIMARY CLARIFICATION
SIDEWATER DEPTH                10.0              FEET
END
DRYING BEDS
RAINFALL                       6                 IN/MO
END
```

4. Code a TITLE card. Code the word title beginning in column 1 followed by the name of the project beginning anywhere after column 6.

   EXAMPLE:

```
TITLE EXAMPLE PROBLEM
```

5. Refer to the sketch in 1 above and code the scheme description as outlined in section 2-7 beginning on page 2-10.

   a. Code "LIQUID" (for Liquid Line) beginning in column 1 followed by one line for each block with the word "BLOCK" beginning in column 1, the first <u>treatment</u> process key word beginning with column 11, MOD number in column 17, and alternative <u>treatment</u> processes key words and MOD numbers in consecutive 7 column intervals beginning with column 18. The MOD number should always be in the seventh column.

b. Code "SECOND" (for Secondary Sludge Line) beginning in column 1 followed by one line for each block with the <u>treatment</u> processes coded as described in 5a. above.

c. Code "PRIMAR" (for Primary Sludge Line) beginning in column 1 followed by one line for each block with the <u>treatment</u> processes coded as described in 5a. above.

d. Repeat beginning with "LIQUID" for each additional treatment scheme.

EXAMPLE:

```
LIQUID LINE
BLOCK      PRELIM
BLOCK      PRIMAR
BLOCK      STEP A TRICKL
BLOCK      CHLORI
SECONDARY  SLUDGE LINE
BLOCK      A MIX
PRIMARY    SLUDGE LINE
BLOCK      AEROBI ANAERO
BLOCK      DRYING
BLOCK      HAULIN
```

6. Examine the default data for the waste influent (page 2-16) and select those items one wishes to change. Code a waste influent header card and data cards for those items wished to change.

   a. Code "WASTE" (for Waste Influent Characteristics) beginning in column 1.

   b. Code "AVERAG" (for Average Flow) on the next line beginning in column 1 and the numeric value for the average flow (MGD) anywhere after column 6.

   c. Code one line each for minimum flow and maximum flow, if desired, and other parameters (listed on pages 2-17, 18) one wishes to change with the first six letters, numbers or spaces of the characteristic beginning in column 1 and the numeric data beginning anywhere after column 6.

EXAMPLE: After examining the waste influent default data, it is desired to change the BOD5 to 300 mg/ℓ and the oil and grease to zero. An average flow of 10 mgd is desired. Code the following:

```
WASTE INFLUENT
AVERAGE FLOW         FINAL = 10.0  INITIAL = 5.0     MGD
BOD5                          300                   MG/L
OIL AND GREASE                  0                   MG/L
```

7. Code a desired effluent header card and data for those items desired to be checked. Those trains that do not meet the specified effluent values will be discarded. If only a few trains have been specified, use this option with care as overrigid specifications may cause all of the alternative trains to be discarded.

   Code "Desire" (for Desired Effluent Characteristics) in column 1 followed by one line for each effluent characteristic (same as listed for Waste Influent on pages 2-17, 18) one wishes to have checked. Only the treatment trains meeting the limits specified will be saved. If one does not wish to specify any affluent limits, only the "DESIRE" line is needed.

   EXAMPLE: As only four trains have been specified in this sample problem, no desired characteristics will be specified. This will allow all four trains to be retained. They may be examined for effectiveness after they are printed. In this case, only the desired effluent header card will have to be coded as follows:

   DESIRED EFFLUENT CHARACTERISTICS

8. Review the unit cost default data (page 2-21) and select those items desired to change. Code these data items following a unit cost header card and terminate this input with an END card.

   a. Code "UNIT C" beginning in column 1.

   b. Code one line for each item selected from the list on pages 2-19 and 20 with the first six letters or spaces of the name of the item beginning in column 1 and the numeric value, in the units specified, anywhere after column 6.

   c. Code one line for each applicable optional unit cost (identified by the subscript "f" on page 2-20). Default data will be used if no numeric value is provided.

   d. Code "END" beginning in column 1.

   If no unit costs are specified, code only A. and D. above the "UNIT C" and "END" lines.

   EXAMPLE: It is desired to change the building costs, excavation costs, concrete costs, and the Marshall and Swift and EPA (Environmental Protection Agency) indices. Code the following:

```
UNIT COSTS
BUILDING                                 42.0          $/SQ FT
EXCAVATION                               1.75          $/CU YD
WALL CONCRETE                            275.0         $/CU YD
SLAB CONCRETE                            230.0         $/CU YD
MARSHALL AND SWIFT                       545.0
SMALL CITY EPA INDEX                     140.0
END
```

9. Refer to section 2-11 (page 2-22) and select the type of output desired. Code the appropriate output control cards followed by the GO card.

EXAMPLE: The cost information for all four trains is desired and complete design information including construction quantities for the most cost-effective train. Code the following:

CONTROL CARDS

LIST		4	TRAINS
PRINT TRAIN NO 1			
OUTPUT QUANTITIES			
GO	I = 6.625	30 YEARS	CP = 3

10. Assemble all data in the order coded above and submit it to the CAPDET program.

EXAMPLE: The complete data list for the example coded above would be:

```
PRIMARY CLARIFICATION
SIDEWATER DEPTH                                  10.0       FT
END
DRYING BEDS
RAINFALL                                         6          IN/MO
END
TITLE EXAMPLE PROBLEM
LIQUID LINE
BLOCK      PRELIM
BLOCK      PRIMAR
BLOCK      STEP A TRICKL
BLOCK      CHLORI
SECONDARY  SLUDGE LINE
BLOCK      A MIX
PRIMARY    SLUDGE LINE
BLOCK      AEROBI ANAERO
BLOCK      DRYING
BLOCK      HAULIN
WASTE INFLUENT
AVERAGE FLOW  FINAL = 10.0  INITIAL = 10.0      MGD
BOD5                                 300        MG/L
OIL AND GREASE                       0          MG/L
DESIRED EFFLUENT CHARACTERISTICS
UNIT COSTS
BUILDING                             42.0       $/SQ FT
EXCAVATION                           1.75       $/CU YD
WALL CONCRETE                        275.0      $/CU YD
SLAB CONCRETE                        230.0      $/CU YD
MARSHALL AND SWIFT                   545.0
SMALL CITY EPA INDEX                 140.0
END
CONTROL CARDS
LIST                                 4          TRAINS
PRINT TRAIN NO 1
OUTPUT QUANTITIES
GO                 I = 6.625    YEARS = 30      CP = 3
```

APPENDIX C

CAPDET EXAMPLE PROBLEM OUTPUT

This section provides the user with the output of the example problem outlined in Appendix B.

```
***** ****************************
PRIMARY CLARIFICATION
SIDEWATER DEPTH      10.0 FEET
END
DRYING BEDS
RAINFALL              6.0 INCHES/MONTH
END
TITLE     EXAMPLE PROBLEM  APPENDIX C
LIQUID LINE
BLOCK      PRELIM
BLOCK      PRIMAR
BLOCK      STEP A TRICKL
BLOCK      CHLORI
SECONDARY SLUDGE LINE
BLOCK      A MIX
PRIMARY SLUDGE LINE
BLOCK      AEROBI ANAERO
BLOCK      DRYING
BLOCK      HAULIN
WASTE INFLUENT
AVERAGE FLOW         10.0 MGD   QINIT  5.0 MGD
BOD5                300.0 MG/L
OIL AND GREASE        0.0 MG/L
DESIRED EFFLUENT CHARACTERISTICS
UNIT COSTS
BUILDING             42.00  $/SQFT
EXCAVATION            1.75  $/CUYD
WALL CONCRETE       275.00  $/CUYD
SLAB CONCRETE       230.00  $/CUYD
MARSHALL AND SWIFT 545.00
SMALL CITY EPA INDEX  140.00
END
CONTROL CARDS
LIST                4 TRAINS
PRINT TRAIN NO  1
OUTPUT QUANTITIES
GO              I=6.625     30 YEARS  CP=3 YEARS
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                      COST ANALYSIS INPUT PARAMETERS
                          INTEREST RATE                  6.625 PERCENT
                          PLANNING PERIOD                   30 YEARS


        UNIT PRICES AND COSTS INDICES

      I BUILDING                               42.00 $/SQFT
      I EXCAVATION                              1.75 $/CUYD
      I WALL CONCRETE                         275.00 $/CUYD
      I SLAB CONCRETE                         230.00 $/CUYD
      I MARSHALL AND SWIFT INDEX              545.00
      D CRANE RENTAL                           67.00 $/HR
      I EPA CONSTRUCTION COST INDEX           140.00
      D CANOPY ROOF                            15.75 $/SQFT
      D LABOR RATE                             13.40 $/HR
      D OPERATOR CLASS II                       7.50 $/HR
      D ELECTRICITY                              .04 $/KWHR
      D CHEMICAL COSTS
         LIME                                    .03 $/LB
         ALUM                                    .04 $/LB
         IRON SALTS                              .06 $/LB
         POLYMER                                1.62 $/LB
      D ENGINEERING NEWS RECORD COST INDEX   2886.00
      D HANDRAIL                               25.20 $/FT
      D PIPE COST INDEX                       295.20
      D PIPE INSTALLATION LABOR RATE           14.70 $/HR
      D EIGHT INCH PIPE                         9.08 $/FT
      D EIGHT INCH PIPE BEND                   86.82 $/UNIT
      D EIGHT INCH PIPE TEE                   128.49 $/UNIT
      D EIGHT INCH PIPE VALVE                1346.16 $/UNIT


   EXAMPLE PROBLEM  APPENDIX C

    PRESENT TRN    PROJECT TRN  CONSTRUCT TRN   O&M    TRN   ENERGY TRN
      WORTH  #      COST    #     COST      #   COST     #    COST   #
   15620440   3   11759628  3    8309582    3   314243   4    32310  4
   16841556   4   13105579  4    9265984    4   319375   3    45841  3
   21869608   1   15713800  1   11119715    1   706590   1   278009  2
   26154547   2   18109516  2   12822722    2   717230   2   291055  1
TRAIN NO   1
LIQUID    PREL  0  PRIM  0  STEP  0  CHLO  0
SECONDARY A MI  0
PRIMARY   AERO  0  DRYI  0  HAUL  0

TRAIN NO   2
LIQUID    PREL  0  PRIM  0  STEP  0  CHLO  0
SECONDARY A MI  0
PRIMARY   ANAE  0  DRYI  0  HAUL  0

TRAIN NO   3
LIQUID    PREL  0  PRIM  0  TRIC  0  CHLO  0
SECONDARY A MI  0
PRIMARY   AERO  0  DRYI  0  HAUL  0

TRAIN NO   4
LIQUID    PREL  0  PRIM  0  TRIC  0  CHLO  0
SECONDARY A MI  0
PRIMARY   ANAE  0  DRYI  0  HAUL  0
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    EXAMPLE PROBLEM  APPENDIX C                    PRESENT    1  TRAIN NO    3
                                    INFLUENT


                            LIQUID CHARACTERISTICS
FLOW        (MGD)      SOLIDS     (MG/L)               (MG/L)          (MG/L)
MAXIMUM   10.0000      SUSPENDED  200.00      BOD5     300.00       TKN 45.00
AVERAGE   10.0000      VOLATILE    60.00 %    BOD5S     75.00       NH3 25.00
MINIMUM   10.0000      SETTLEABLE  15.00      COD      500.00       NO2   .00
                                              CODS     400.00       NO3   .00
TEMP (W)   10.0 C      OIL & GREASE     .00   PO4       18.00
TEMP (S)   23.0 C      CATIONS       160.00
PH          7.6        ANIONS        160.00


                            SLUDGE CHARACTERISTICS
                            PRIMARY          SECONDARY
   VOLUME (GAL/D)             .00               .00
     % SOLIDS                 .00               .00
     % VOLATILE               .00               .00
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   EXAMPLE PROBLEM  APPENDIX C                   PRESENT    1  TRAIN NO    3
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MECHANICALLY CLEANED BAR SCREEN

D BAR SIZE                                    .250+00 INCHES
D BAR SPACING                                 .150+01 INCHES
D SLOPE OF BARS FROM HORIZONTAL               .300+02 DEG
  HEAD LOSS THROUGH SCREEN                    .206-01 FEET
D APPROACH VELOCITY                           .250+01 FT/SEC
D AVERAGE FLOW THROUGH VELOCITY               .250+01 FT/SEC
D MAXIMUM FLOW THROUGH VELOCITY               .300+01 FT/SEC
  SCREEN CHANNEL WIDTH                        .616+01 FEET
D AVERAGE CHANNEL DEPTH                       .100+01 FEET

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  EXAMPLE PROBLEM  APPENDIX C                     PRESENT   1  TRAIN NO   3

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  AERATED GRIT CHAMBER

  MAXIMUM FLOW                                   .154+02 CFS
  AVERAGE FLOW                                   .154+02 CFS
  MINIMUM FLOW                                   .154+02 CFS
  TEMPERATURE                                    .100+02 DEG C
D MAXIMUM FLOW THROUGH VELOCITY                  .113+00 FPS
D AVERAGE FLOW THROUGH VELOCITY                  .113+00 FPS
D SIZE SMALL. PART. 100% REMOVED                 .200+00 MM
D SPECIFIC GRAVITY OF PARTICLE                   .265+01
D NUMBER OF UNITS                                .200+01
  MAXIMUM FLOW/UNIT                              .770+01 CFS
D WIDTH OF CHANNEL                               .170+02 FEET
D DEPTH OF CHANNEL                               .400+01 FEET
  LENGTH OF CHANNEL                              .170+02 FEET
  SETTLING VELOCITY OF PARTICLE                  .105+03 FPS
D DETENTION TIME                                 .250+01 MIN
  VOLUME OF GRIT                                 .400+02 CUFT/DAY
D AIR SUPPLY                                     .300+01 CFM

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  EXAMPLE PROBLEM  APPENDIX C                     PRESENT   1  TRAIN NO   3

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COMMINUTION

D NUMBER OF UNITS                                .200+01 UNITS
  DRUM DIAMETER                                  .250+02 INCHES
  DRUM RPM                                       .250+02 REV/MIN
  AVERAGE SLOT WIDTH                             .380+00 INCHES
  HORSEPOWER/UNIT                                .150+01 HP
  STANDARD HEIGHT                                .579+01 FEET
  STANDARD NET WEIGHT                            .210+04 POUNDS

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                          LIQUID CHARACTERISTICS
FLOW       (MGD)       SOLIDS     (MG/L)                (MG/L)          (MG/L)
MAXIMUM   10.0000      SUSPENDED  200.00       BOD5     300.00      TKN 45.00
AVERAGE   10.0000      VOLATILE    60.00 %     BOD5S     75.00      NH3 25.00
MINIMUM   10.0000      SETTLEABLE  15.00       COD      500.00      NO2   .00
                                               CODS     400.00      NO3   .00
TEMP (W)   10.0 C      OIL & GREASE      .00   PO4       18.00
TEMP (S)   23.0 C      CATIONS        160.00
PH          7.6        ANIONS         160.00

                             SLUDGE CHARACTERISTICS
                             PRIMARY          SECONDARY
   VOLUME (GAL/D)              .00               .00
     % SOLIDS                  .00               .00
     % VOLATILE                .00               .00
   EXAMPLE PROBLEM  APPENDIX C                  PRESENT   1  TRAIN NO   3

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**** SUPERNATANT FROM SLUDGE LINE PROCESSES ADDED TO LIQUID LINE ****


                         LIQUID CHARACTERISTICS
FLOW        (MGD)      SOLIDS    (MG/L)              (MG/L)          (MG/L)
MAXIMUM   10.0700      SUSPENDED  222.24     BOD5     301.39     TKN 44.81
AVERAGE   10.0700      VOLATILE     60.00 %  BOD5S     75.35     NH3 24.83
MINIMUM   10.0700      SETTLEABLE  15.00     COD      514.60     NO2    .00
                                             CODS     411.68     NO3    .00
TEMP (W)   10.0 C      OIL & GREASE     .00  PO4       18.00
TEMP (S)   23.0 C      CATIONS       160.00
PH            7.6      ANIONS        160.00

                          SLUDGE CHARACTERISTICS
                          PRIMARY          SECONDARY
   VOLUME (GAL/D)           .00                .00
     % SOLIDS               .00                .00
     % VOLATILE             .00                .00
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   EXAMPLE PROBLEM  APPENDIX C                  PRESENT   1  TRAIN NO   3

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PRIMARY CLARIFIER

 CIRCULAR CLARIFIER

D SURFACE OVERFLOW RATE              .100+04 GAL/DAY/SQFT
  SURFACE AREA                       .101+05 SQ FT
I SIDE WATER DEPTH                   .100+02 FEET
  DETENTION TIME                     .180+01 HOURS
  SOLID LOADING                      .185+01 LB/SQFT/DAY
D WEIR LOADING                       .150+05 GAL/DAY/FT
  WEIR LENGTH                        .671+03 FEET
  VOLUME OF SLUDGE PRODUCED          .309+05 GAL/DAY
D SUSPENDED SOLIDS REMOVAL           .580+02 PERCENT
D BOD REMOVAL                        .320+02 PERCENT
D COD REMOVAL                        .400+02 PERCENT
D TKN REMOVAL                        .500+01 PERCENT
D PO4 REMOVAL                        .500+01 PERCENT

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   EXAMPLE PROBLEM  APPENDIX C                        PRESENT    1  TRAIN NO    3

QUANTITIES FOR SEDIMENTATION

CIRCULAR CLARIFIER

PRIMARY CLARIFIER
EXCESS CAPACITY FACTOR                               .100+01
CALCULATED SURFACE AREA                              .101+05 SQ FT
ADJUSTED SURFACE AREA                                .101+05 SQ FT
AVERAGE DAILY WASTEWATER FLOW                        .101+02 MGD
NUMBER OF CIRCULAR CLARIFIERS                              4
NUMBER OF BATTERIES                                        1
SURFACE AREA PER UNIT                                .252+04 SQ FT
DIAMETER OF UNIT                                     .570+02 FEET
EARTHWORK REQUIRED                                   .125+06 CU FT
SIDEWATER DEPTH                                      .100+02 FEET
THICKNESS OF THE SLAB                                .104+02 INCHES
WALL THICKNESS                                       .120+02 INCHES
TOTAL  WALL CONCRETE REQUIRED                        .871+04 CU FT
TOTAL SLAB CONCRETE REQUIRED                         .106+05 CU FT
MAINTENANCE MANPOWER REQUIRED                        .566+03 MAN-HOURS/YR
OPERATION MANPOWER REQUIRED                          .103+04 MAN-HOURS/YR
ELECTRICAL ENERGY REQUIRED                           .101+05 KWHR/YR


                             LIQUID CHARACTERISTICS
FLOW        (MGD)       SOLIDS      (MG/L)               (MG/L)           (MG/L)
MAXIMUM   10.0700       SUSPENDED     93.34     BOD5     204.95       TKN 42.57
AVERAGE   10.0700       VOLATILE      60.00 %   BOD5S     75.35       NH3 24.83
MINIMUM   10.0700       SETTLEABLE      .00     COD      411.68       NO2    .00
                                                CODS     411.68       NO3    .00
TEMP (W)   10.0 C       OIL & GREASE      .00   PO4       17.10
TEMP (S)   23.0 C       CATIONS        160.00
PH          7.6         ANIONS         160.00


                               SLUDGE CHARACTERISTICS
                              PRIMARY         SECONDARY
   VOLUME (GAL/D)            30905.71            .00
     % SOLIDS                    4.00            .00
     % VOLATILE                 60.00            .00

  EXAMPLE PROBLEM  APPENDIX C                        PRESENT    1  TRAIN NO    3

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TRICKLING FILTRATION

D SOLID PRODUCTION RATE                              .650+00 LB/LB BOD5
D HYDRAULIC  LOADING RATE                            .750+00 GPM/SQFT
D SURFPAC MEDIA
D SPECIFIC SURFACE AREA                              .260+02 SQFT/CUFT
  REACTION RATE CONSTANT                             .156-02
  RECIRCULATION RATIO                                .220+00
  TOTAL HYDRAULIC LOADING RATE                       .915+00 GPM/SQFT
  DEPTH OF FILTER TOWER                              .204+02 FEET
  NUMBER OF STAGES                                         2
  SURFACE AREA OF FILTER                             .932+04 SQ FT
  MEDIA VOLUME                                       .380+06 CU FT

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   EXAMPLE PROBLEM  APPENDIX C                         PRESENT   1  TRAIN NO   3

QUANTITIES FOR TRICKLING FILTER

  NUMBER OF TOWERS                                         4
  VOLUME PER FILTER TOWER                            .951+05 CU FT
  DIAMETER OF FILTER TOWER                           .770+02 FEET
  TOTAL NUMBER OF POSTS                                  331
  TOTAL LENGTH OF PRECAST BEAMS                      .101+05 FEET
  TOTAL REINFORCED WALL CONCRETE                     .350+05 CU FT
  TOTAL REINFORCED SLAB CONCRETE                     .124+05 CU FT
  TOTAL EARTHWORK REQUIRED                           .236+06 CU FT
  OPERATIONAL MANPOWER                               .526+03 MAN-HRS/YEAR
  MAINTENANCE MANPOWER                               .409+03 MAN-HRS/YEAR
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   EXAMPLE PROBLEM  APPENDIX C                         PRESENT   1  TRAIN NO   3

QUANTITIES FOR SLUDGE RECYCLE PUMPING

AVERAGE DAILY PUMPING RATE                           .671+01 MGD
TOTAL PUMPING CAPACITY                               .123+02 MGD
DESIGN CAPACITY PER PUMP                             .426+04 GPM
NUMBER OF PUMPS                                            3
NUMBER OF BATTERIES                                        1
AREA OF PUMP BUILDING                                .442+03 SQ FT
VOLUME OF EARTHWORK REQUIRED                         .354+04 CU FT
FIRM PUMPING CAPACITY                                .671+01 MGD
OPERATING MANPOWER REQUIRED                          .562+03 MAN-HOURS/YR
MAINTENANCE MANPOWER REQUIRED                        .477+03 MAN-HOURS/YR
ELECTRICAL ENERGY REQUIRED                           .448+06 KWHR/YR
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   EXAMPLE PROBLEM  APPENDIX C                PRESENT   1  TRAIN NO   3

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SECONDARY CLARIFIER FOR TRICKLING FILTRATION

 CIRCULAR CLARIFIER

  SOLIDS LOADING RATE                    .107+02 LB/SQFT/DAY
D SURFACE OVERFLOW RATE                  .800+03 GAL/SQFT/DAY
  DETENT"ON TIME                         .202+01 HOURS
D WEIR OVERFLOW RATE                     .150+05 GAL/FT/DAY
D TANK SIDEWATER DEPTH                   .900+01 FEET
  WEIR LENGTH                            .819+03 FEET
  VOLUME OF WASTED SLUDGE                .161+05 GAL/DAY
D UNDERFLOW CONCENTRATION                .300+01 PERCENT
  TOTAL SURFACE AREA                     .126+05 SQ FT

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                         LIQUID CHARACTERISTICS
FLOW       (MGD)     SOLIDS     (MG/L)              (MG/L)        (MG/L)
MAXIMUM  10.0700     SUSPENDED    20.00     BOD5     30.00     TKN 20.86
AVERAGE  10.0700     VOLATILE     80.00 %   BOD5S    15.00     NH3 20.86
MINIMUM  10.0700     SETTLEABLE     .00     COD      45.00     NO2   .00
                                            CODS     22.50     NO3  8.94
TEMP (W)  10.0 C     OIL & GREASE     .00   PO4       8.38
TEMP (S)  23.0 C     CATIONS       160.00
PH           7.6     ANIONS        160.00

                          SLUDGE CHARACTERISTICS
                          PRIMARY          SECONDARY
   VOLUME (GAL/D)        30905.71          16112.00
     % SOLIDS                4.00              3.00
     % VOLATILE             60.00             80.00
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   EXAMPLE PROBLEM  APPENDIX C                PRESENT   1  TRAIN NO   3

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CHLORINATION

  MAXIMUM FLOW                           .101+02 MGD
  AVERAGE FLOW                           .101+02 MGD
D CONTACT TIME                           .300+02 MIN
  TOTAL VOLUME                           .210+06 GAL
  AVERAGE CHLORINE REQUIREMENT           .840+03 LB/DAY
  PEAK CHLORINE REQUIREMENT              .840+03 LB/DAY
  COLIFORM REDUCTION                     .996+02 PERCENT

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   EXAMPLE PROBLEM  APPENDIX C                         PRESENT    1  TRAIN NO    3

QUANTITIES FOR CHLORINATION

NUMBER OF CHLORINATORS AND EVAPORATORS                          1
CHLORINATION BUILDING AREA                                 .220+03 SQ FT
NUMBER OF CHLORINE CYLINDERS                                   13
AREA OF CHLORINE STORAGE BUILDING                          .182+04 SQ FT
AVERAGE DAILY WASTEWATER FLOW MGD                          .101+02 MGD
VOLUME OF EARTHWORK REQUIRED                               .145+05 CU FT
VOLUME OF WALL CONCRETE                                    .568+04 CU FT
VOLUME OF SLAB CONCRETE                                    .309+04 CU FT
CHLORINE REQUIREMENT PER YEAR                              .153+03 TONS/YR
OPERATIONAL LABOR                                          .145+04 MAN-HOURS/YR
MAINTENANCE MANPOWER REQUIRED                              .366+03 MAN-HOURS/YR
ELECTRICAL ENERGY REQUIRED                                 .131+06 KWHR/YR
CHLORINE REQUIREMENT                                       .840+03 LBS/DAY
O & M MATERIAL AND SUPPLY COSTS                            .312+01 PERCENT


                          LIQUID CHARACTERISTICS
FLOW        (MGD)      SOLIDS     (MG/L)              (MG/L)         (MG/L)
MAXIMUM   10.0700      SUSPENDED    20.00     BOD5     30.00      TKN 20.86
AVERAGE   10.0700      VOLATILE     50.00 %   BOD5S    15.00      NH3 20.86
MINIMUM   10.0700      SETTLEABLE     .00     COD      45.00      NO2   .00
                                              CODS     22.50      NO3  8.94
TEMP (W)   10.0 C      OIL & GREASE     .00   PO4       8.38
TEMP (S)   23.0 C      CATIONS       160.00
PH          7.6        ANIONS        160.00


                             SLUDGE CHARACTERISTICS
                             PRIMARY          SECONDARY
   VOLUME (GAL/D)          30905.71           16112.00
     % SOLIDS                  4.00               3.00
     % VOLATILE               60.00              80.00
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    EXAMPLE PROBLEM  APPENDIX C                         PRESENT   1  TRAIN NO   3
QUANTITIES FOR CHLORINATION

NUMBER OF CHLORINATORS AND EVAPORATORS                        1
CHLORINATION BUILDING AREA                              .220+03 SQ FT
NUMBER OF CHLORINE CYLINDERS                                 13
AREA OF CHLORINE STORAGE BUILDING                       .182+04 SQ FT
AVERAGE DAILY WASTEWATER FLOW MGD                       .101+02 MGD
VOLUME OF EARTHWORK REQUIRED                            .145+05 CU FT
VOLUME OF WALL CONCRETE                                 .568+04 CU FT
VOLUME OF SLAB CONCRETE                                 .309+04 CU FT
CHLORINE REQUIREMENT PER YEAR                           .153+03 TONS/YR
OPERATIONAL LABOR                                       .145+04 MAN-HOURS/YR
MAINTENANCE MANPOWER REQUIRED                           .365+03 MAN-HOURS/YR
ELECTRICAL ENERGY REQUIRED                              .131+06 KWHR/YR
CHLORINE REQUIREMENT                                    .840+03 LBS/DAY
O & M MATERIAL AND SUPPLY COSTS                         .312+01 PERCENT


                           LIQUID CHARACTERISTICS
FLOW        (MGD)      SOLIDS    (MG/L)               (MG/L)           (MG/L)
MAXIMUM  10.0700       SUSPENDED   20.00     BOD5      30.00       TKN 20.86
AVERAGE  10.0700       VOLATILE    50.00 %   BOD5S     15.00       NH3 20.86
MINIMUM  10.0700       SETTLEABLE    .00     COD       45.00       NO2   .00
                                             CODS      22.50       NO3  8.94
TEMP (W)   10.0 C      OIL & GREASE    .00   PO4        8.38
TEMP (S)   23.0 C      CATIONS      160.00
PH          7.6        ANIONS       160.00

                            SLUDGE CHARACTERISTICS
                            PRIMARY          SECONDARY
    VOLUME (GAL/D)         30905.71           16112.00
      % SOLIDS                 4.00               3.00
      % VOLATILE              60.00              80.00
    EXAMPLE PROBLEM  APPENDIX C
                                                         PRESENT   1  TRAIN NO   3
 QUANTITIES FOR CHLORINATION

 NUMBER OF CHLORINATORS AND EVAPORATORS
 CHLORINATION BUILDING AREA                                     1
 NUMBER OF CHLORINE CYLINDERS                           .220+03 SQ FT
 AREA OF CHLORINE STORAGE BUILDING                             13
 AVERAGE DAILY WASTEWATER FLOW MGD                      .182+04 SQ FT
 VOLUME OF EARTHWORK REQUIRED                           .101+02 MGD
 VOLUME OF WALL CONCRETE                                .145+05 CU FT
 VOLUME OF SLAB CONCRETE                                .568+04 CU FT
 CHLORINE REQUIREMENT PER YEAR                          .309+04 CU FT
 OPERATIONAL LABOR                                      .153+03 TONS/YR
 MAINTENANCE MANPOWER REQUIRED                          .145+04 MAN-HOURS/YR
 ELECTRICAL ENERGY REQUIRED                             .366+03 MAN-HOURS/YR
 CHLORINE REQUIREMENT                                   .131+06 KWHR/YR
 O & M MATERIAL AND SUPPLY COSTS                        .840+03 LBS/DAY
                                                        .312+01 PERCENT


                               LIQUID CHARACTERISTICS
FLOW        (MGD)         SOLIDS      (MG/L)
MAXIMUM   10.0700         SUSPENDED    20.00              (MG/L)            (MG/L)
AVERAGE   10.0700         VOLATILE     80.00 %    BOD5      30.00       TKN 20.86
MINIMUM   10.0700         SETTLEABLE     .00      BOD5S     15.00       NH3 20.86
                                                  COD       45.00       NO2   .00
TEMP (W)    10.0 C                                CODS      22.50       NO3  8.94
TEMP (S)    23.0 C        OIL & GREASE      .00   PO4        8.38
PH           7.6          CATIONS        160.00
                          ANIONS         160.00


                                 SLUDGE CHARACTERISTICS
                                PRIMARY              SECONDARY
   VOLUME (GAL/D)             30905.71              16112.00
     % SOLIDS                     4.00                  3.00
     % VOLATILE                  60.00                 80.00
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  EXAMPLE PROBLEM  APPENDIX C                PRESENT   1  TRAIN NO   3

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**** SECONDARY SLUDGE LINE MIXED INTO PRIMARY SLUDGE LINE ****


                              INFLUENT


                          LIQUID CHARACTERISTICS
FLOW        (MGD)     SOLIDS    (MG/L)              (MG/L)        (MG/L)
MAXIMUM  10.0700      SUSPENDED    20.00    BOD5     30.00      TKN 20.86
AVERAGE  10.0700      VOLATILE     80.00 %  BOD5S    15.00      NH3 20.86
MINIMUM  10.0700      SETTLEABLE     .00    COD      45.00      NO2   .00
                                            CODS     22.50      NO3  8.94
TEMP (W)   10.0 C     OIL & GREASE    .00   PO4       8.38
TEMP (S)   23.0 C     CATIONS      160.00
PH          7.6       ANIONS       160.00

                           SLUDGE CHARACTERISTICS
                           PRIMARY          SECONDARY
   VOLUME (GAL/D)         47017.71               .00
      % SOLIDS                3.66               .00
      % VOLATILE             65.62               .00
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  EXAMPLE PROBLEM  APPENDIX C                PRESENT   1  TRAIN NO   3

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AEROBIC DIGESTION

  RAW SLUDGE SPECIFIC GRAVITY             .105+01
D DETENTION TIME                          .180+02 DAYS
D VOLATILE SOLIDS DESTROYED               .400+02 PERCENT
D MIXED LIQUOR SOLIDS                     .120+05 MG/L
D SOLIDS IN DIGESTED SLUDGE               .250+01 PERCENT
D ALPHA                                   .900+00
D BETA                                    .900+00
D STANDARD TRANSFER EFFICIENCY            .600+01 PERCENT
  DIGESTER VOLUME                         .846+06 GAL
  VOLATILE SOLIDS LOADING                 .873-01 LB VS/CUFT/DAY
  SOLIDS ACCUMULATED PER DAY              .833+04 LB/DAY
  DIGESTER CAPACITY                       .847+05 LB
  VOLUME OF WASTED SLUDGE                 .387+06 GAL
  SOLIDS RETENTION TIME                   .102+02 DAYS
  OXYGEN REQUIREMENT                      .791+04 LB/DAY
  AIR SUPPLY                              .781+02 CFM/TCFT

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  EXAMPLE PROBLEM  APPENDIX C                    PRESENT   1  TRAIN NO   3

QUANTITIES FOR DIFFUSED AERATION SYSTEM

COMPLETELY MIXED FLOW
AVERAGE DAILY WASTEWATER FLOW                    .470-01 MGD
TOTAL NUMBER OF TANKS                                  2
NUMBER OF BATTERIES                                    1
ACTUAL VOLUME PER TANK                           .566+05 CU FT
PROCESS AIR REQUIREMENT                          .884+04 SCFM
NUMBER OF DIFFUSERS PER TANK                         369
NUMBER OF SWING ARM HEADERS PER TANK                   6
LENGTH OF AERATION TANKS                         .126+03 FEET
PIPE GALLERY WIDTH                               .200+02 FEET
VOLUME OF EARTHWORK REQUIRED                     .727+05 CU FT
REINFORCED SLAB CONCRETE REQUIRED                .168+05 CU FT
REINFORCED WALL CONCRETE REQUIRED                .140+05 CU FT
HANDRAIL LENGTH                                  .879+03 FEET
OPERATION MANPOWER REQUIRED                      .258+04 MAN-HRS/YEAR
MAINTENANCE MANPOWER REQUIRED                    .146+04 MAN-HRS/YEAR
ELECTRICAL ENERGY REQUIRED                       .500+06 KWHR/YEAR
O & M MATERIAL AND SUPPLY COST                   .229+01 PERCENT


                         LIQUID CHARACTERISTICS
FLOW       (MGD)     SOLIDS     (MG/L)             (MG/L)        (MG/L)
MAXIMUM  10.0700     SUSPENDED    20.00    BOD5     30.00     TKN 20.86
AVERAGE  10.0700     VOLATILE     80.00 %  BOD5S    15.00     NH3 20.86
MINIMUM  10.0700     SETTLEABLE     .00    COD      45.00     NO2   .00
                                           CODS     22.50     NO3  8.94
TEMP (W)  10.0 C     OIL & GREASE    .00   PO4       8.38
TEMP (S)  23.0 C     CATIONS      160.00
PH         7.6       ANIONS       160.00

                            SLUDGE CHARACTERISTICS
                            PRIMARY        SECONDARY
   VOLUME (GAL/D)          38046.55              .00
     % SOLIDS                  2.50              .00
     % VOLATILE               53.39              .00
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  EXAMPLE PROBLEM  APPENDIX C                    PRESENT   1  TRAIN NO   3

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SLUDGE DRYING BEDS

  TOTAL SURFACE AREA REQUIRED   .426+06 SQ FT
D INITIAL DEPTH OF SLUDGE       .120+02 INCHES
D FINAL PERCENT SOLIDS          .500+02
  BED HOLDING TIME              .838+02 DAYS

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  EXAMPLE PROBLEM  APPENDIX C                PRESENT   1  TRAIN NO   3

QUANTITIES FOR DRYING BED

TOTAL DRYING BED SURFACE AREA                       .426+06 SQ FT
NUMBER BEDS                                             143
SURFACE AREA OF EACH INDIVIDUAL BED                 .298+04 SQ FT
LENGTH OF EACH BED                                  .149+03 FEET
VOLUME OF EARTHWORK REQUIRED                        .210+07 CU FT
VOLUME CONCRETE FOR DIVIDING WALL                   .138+06 CU FT
VOLUME OF R.C. IN-PLACE FOR TRUCK TRACKS            .640+05 CU FT
VOLUME OF SAND                                      .320+06 CU FT
VOLUME OF GRAVEL                                    .426+06 CU FT
CLAY PIPE DIAMETER                                  .600+01 INCHES
TOTAL LENGTH CLAY PIPE                              .426+05 FEET
SLUDGE SOLIDS PER DAY                               .397+01 TONS/DAY
OPERATION MANPOWER REQUIRED                         .423+04 MAN-HOURS/YR
MAINTENANCE MANPOWER REQUIRED                       .211+04 MAN-HOURS/YR


                        LIQUID CHARACTERISTICS
                                                   (MG/L)         (MG/L)
FLOW       (MGD)      SOLIDS    (MG/L)
MAXIMUM  10.0700      SUSPENDED   20.00     BOD5     30.00      TKN 20.86
AVERAGE  10.0700      VOLATILE    80.00 %   BOD5S    15.00      NH3 20.86
MINIMUM  10.0700      SETTLEABLE    .00     COD      45.00      NO2   .00
                                            CODS     22.50      NO3  6.94
TEMP (W)   10.0 C     OIL & GREASE    .00   PO4       8.38
TEMP (S)   23.0 C     CATIONS      160.00
PH          7.6       ANIONS       160.00


                           SLUDGE CHARACTERISTICS
                           PRIMARY         SECONDARY
   VOLUME (GAL/D)          1902.33             .00
     % SOLIDS                50.00             .00
     % VOLATILE              53.39             .00
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  EXAMPLE PROBLEM  APPENDIX C                PRESENT   1  TRAIN NO   3

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SLUDGE HAULING AND LAND FILLING

  VOLUME OF SLUDGE HAULED              .942+01 CUYD/DAY
  TRUCK CAPACITY                       .190+02 CU YD
D ROUND TRIP TIME TO DISPOSAL SITE     .100+01 HRS
D TRUCK LOADING TIME                   .750+00 HRS
D HOURS OF OPERATION PER DAY           .800+01 HRS
  NUMBER OF TRUCKS REQUIRED                  1
  TONS OF SLUDGE HAULED PER DAY        .833+01 TONS/DAY
D DISTANCE TO DISPOSAL SITE            .100+02 MILES

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   EXAMPLE PROBLEM  APPENDIX C                    PRESENT    1  TRAIN NO    3

QUANTITIES FOR SLUDGE HAULING AND LANDFILL

TOTAL SLUDGE VOLUME HAULED                        .942+01 CUYD/DAY
MAXIMUM ANTICIPATED LANDFILL DOWNTIME             .309+02 DAYS
ANTICIPATED SLUDGE STORAGE HEIGHT                 .800+01 FEET
SLUDGE STORAGE SHED AREA                          .954+03 SQ FT
WIDTH OF SLUDGE STORAGE SHED SLAB                 .218+02 FEET
LENGTH OF SLUDGE STORAGE SHED SLAB                .437+02 FEET
VOLUME OF EARTHWORK                               .281+04 CU FT
VOLUME OF SLAB CONCRETE                           .125+04 CU FT
SURFACE AREA OF CANOPY ROOF                       .954+03 SQ FT
DISTANCE TO DISPOSAL SITE                         .100+02 MILES
ROUND TRIP HAUL DISTANCE                          .200+02 MILES
TONS OF SLUDGE HAULED PER DAY                     .833+01 TONS/DAY
OPERATION MANPOWER REQUIRED                       .147+03 MAN-HOURS/YR
ROUND TRIPS PER DAY PER TRUCK                     .100+01
DISTANCE TRAVELED PER YEAR PER TRUCK              .500+04 MILES/YR
MAINTENANCE AND MATERIAL SUPPLY COST              .650+01 PERCENT


                          LIQUID CHARACTERISTICS
FLOW       (MGD)      SOLIDS     (MG/L)              (MG/L)          (MG/L)
MAXIMUM  10.0700      SUSPENDED    20.00    BOD5      30.00      TKN 20.86
AVERAGE  10.0700      VOLATILE     80.00 %  BOD5S     15.00      NH3 20.86
MINIMUM  10.0700      SETTLEABLE     .00    COD       45.00      NO2   .00
                                            CODS      22.50      NO3  8.94
TEMP (W)  10.0 C      OIL & GREASE    .00   PO4        8.38
TEMP (S)  23.0 C      CATIONS      160.00
PH           7.6      ANIONS       160.00

                            SLUDGE CHARACTERISTICS
                            PRIMARY          SECONDARY
   VOLUME (GAL/D)             .00               .00
     % SOLIDS                 .00               .00
     % VOLATILE               .00               .00
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   EXAMPLE PROBLEM  APPENDIX C                    PRESENT    1  TRAIN NO    3

QUANTITIES FOR BLOWERS

DESIGN CAPACITY FOR BLOWER SYSTEM                 .884+04 SCFM
NUMBER OF BLOWERS FOR MAX AIR REQUIREMENTS           2
CAPACITY OF INDIVIDUAL BLOWERS                    .442+04 SCFM
TOTAL NUMBER OF BLOWERS REQUIRED                     3
BLOWER BUILDING AREA                              .131+04 SQ FT
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   EXAMPLE PROBLEM  APPENDIX C                 PRESENT   1  TRAIN NO   3

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 LIQUID    PREL  0  PRIM  0  TRIC  0  CHLO  0
 SECONDARY A MI  0
 PRIMARY   AERO  0  DRYI  0  HAUL  0

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                                 COST SUMMARY

                                     OPER      MAINT                                                  TOTAL
               CAPITAL     AMMORT    LABOR     LABOR         POWER     MATERIAL     CHEMICAL          O & M
  UNIT          COST         COST     COST      COST          COST         COST         COST           COST
                  $          $/YR     $/YR      $/YR          $/YR         $/YR         $/YR           $/YR
 PRELIMIN*    159346        11909    13915      5897          1859         3983            0          25654
 PRIM CLA     537072        40161     7476      3695           606         5376            0          16745
 TRIC FIL    2510982       187675     3629      2526             0        13603            0          19956
 T SEC CL     593645        44370     8551      4006           419         5936            0          18910
 SLU PUMP     179619        14901     4088      2945         17909         1257            0          26199
 CHLORINA     175706        14035    10558      2258          5258         5485        17906          41467
 AERO DIG     441041        33231    18803      9013         19996        10119            0          57925
 DRY BLDS    1933082       167321    30771     13051             0        17397            0          61219
 HAUL BLF      72882        11680     1071         0             0        11054            0          12125
 BLOWERS      207756        15528        0         0             0            0            0              0

 SUB TOTAL   6811133       520795    99067     43193         65861        74209            0         280202

 * WARNING - COST ESTIMATES ARE FROM PARAMETRIC EQUATIONS

 DIRECT COSTS
  PROFIT/OVERHEAD                 1498449 $

    SUB TOTAL (OTHER DIRECT)      1498449 $       TOTAL CONSTRUCTION COST   8309582 $

 INDIRECT COSTS
  MISC NON CONST COSTS             615479 $
  ADMIN/LEGAL                      166191 $
  201 PLANNING                     290835 $
  A/E DESIGN FEE                   497616 $
  INSPECTION                       166191 $
  CONTINGENCIES                    664766 $
  TECHNICAL COSTS                  166191 $

    SUB TOTAL (INDIRECT)          2367667 $

 LAND COSTS                         20000 $     (   20. ACRES)
 INTEREST DURING CONSTRUCTION     1062979 $

 ADMINISTRATIVE COST                28616 $/YR
 LABORATORY COST                    28649 $/YR



   TOTAL PROJECT COST  11759628 $     TOTAL CONSTRUCTION COST    8309582 $
   FINAL YEAR O & M      319375 $/YR  TOTAL STEP III COST       10971379 $
   INITIAL YEAR O & M    296654 $/YR  PRESENT WORTH (APP. A)    15620440 $
   EXAMPLE PROBLEM  APPENDIX C                 PRESENT   1  TRAIN NO    3

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USFR CHARGE SUMMARY

D EPA GRANT                                         .750+02 PERCENT
D STATE GRANT                                       .000    PERCENT
D ALLOWANCE FOR FINANCING                           .300+01 PERCENT
  BONDS               PERCENT  RATE  LIFE
D   REVENUE           100.00 10.00    30
D   GENERAL OBLIGATION   .00   .00    30
D   OTHER                .00   .00    30
D EXISTING SEWER RATE                               .000    $/TGAL
D PERSONS PER HOUSEHOLD                             .350+01
D GALLONS/CAPITA/DAY (WATER USE)                    .100+03 GPCPD
  TOTAL PROJECT COST                                .119+08 $
  EPA ELIGIBLE COST                                 .117+08 $
  LOCAL SHARE                                       .306+07 $
  ANNUAL DEBT SERVICE                               .323+06 $/YEAR
  PRINCIPAL AND INTEREST RESERVE                    .461+05 $/YEAR
  CONTINGENCY RESERVE                               .461+05 $/YEAR
  TOTAL ANNUAL OPERATING COST                       .734+06 $/YEAR
  TREATMENT COST
    COST PER 1000 GALLONS TREATED (NEW SYSTEM)      .201+00 $/TGAL
    COST PER 1000 GALLONS TREATED (TOTAL SYSTEM)    .201+00 $/TGAL
    COST PER BILLING UNIT (NEW SYSTEM)              .402+00 $/TGAL
    COST PER BILLING UNIT (TOTAL SYSTEM)            .402+00 $/TGAL
    COST PER HOUSEHOLD (NEW SYSTEM)                 .423+01 $/MONTH
    COST PER HOUSEHOLD (TOTAL SYSTEM)               .423+01 $/MONTH
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APPENDIX D

UNIT COST INDICES

This section provides the user with a list of the items by unit process which are updated by a unit cost index other than the Marshall and Swift equipment cost index. Each item is updated by the specified unit cost index only if default values are used. No user-specified unit cost items will be updated.

a. Large system unit processes:

Unit Processes	Key Word	Cost Item	1977 Cost Standard Equipment	Cost Index
Activated Sludge Units				
Complete Mix	COMPLE	Mechanical Aerator	16,300	MAS
Contact Stabilization	CONTAC	Diffuser	6.50	MAS
Extended Aeration	EXTEND	Swing Arm Diffuser	5,000	MAS
High Rate	HIGH R	Pump	17,250	MAS
Plug Flow	PLUG F	Diffuser Piping	Parametric	PIPE
Air Flotation	AIR FL	Air Flotation Unit	44,200	MAS
Aerated Lagoon	AERATE	Mechanical Aerator	13,960	MAS
Aerobic Digestion	AEROBI	Mechanical Aerator	16,300	MAS
		Diffuser	6.50	MAS
		Swing Arm Diffuser	5,000	MAS
		Diffuser Piping	Parametric	PIPE
Anaerobic Digestion	ANAERO	Floating Cover	71,000	MAS
		Gas Circulation Unit	32,000	MAS
		Heating Unit	40,000	MAS
		Gas Safety Equipment	7,100	MAS
		Sludge Pump	2,500	MAS
		Natural Gas	2.30	ENR
		8-in. Pipe	7.41	PIPE
		8-in. Bend	70.88	PIPE
		8-in. Tee	104.90	PIPE
		8-in. Valve	1,099	PIPE
Anion Exchange	ANION	Capital Cost	Parametric	EPA
Attached Growth Denitrification	ATTACH	Media	3.00	MAS
		Distribution System	40.00	MAS
		Pump	17,250	MAS
		Methanol	0.90	ENR
		Methanol Feed System	Parametric	EPA
Blowers	None	Rotary Blower	16,000	MAS
		Multistage Centrifugal Blower	45,000	MAS
		Single-Stage Centrifugal Blower	300,000	MAS
Carbon Adsorption	CARBON	Underdrain System	35.00	MAS
		Control Gate Unit	17,300	MAS
		Furnace Unit	825,000	MAS
		Fuel Oil	0.75	ENR
		Carbon	0.56	EPA
		Pump	17,250	MAS
Cation Exchange	CATION	Capital	Parametric	EPA
Centrifugation	CENTRI	Centrifuge	120,000	MAS

Unit Processes	Key Word	Cost Item	1977 Cost Standard Equipment	Cost Index
Chemical Feed Systems	None	Alum System	Parametric	EPA
		Iron Salts System	Parametric	EPA
		Lime System	Parametric	EPA
		Polymer System	Parametric	EPA
Chlorination	CHLORI	Chlorine	100.00	ENR
		Chlorinator	2,700	MAS
Coagulation	COAGUL	Upflow Clarifier	110,000	MAS
Comminution	COMIN	Capital Cost	Parametric	EPA
Counter Current Ammonia Stripping	COUNTE	Capital Cost	Parametric	EPA
Cross Current Ammonia Stripping	CROSS	Capital Cost	Parametric	EPA
Suspended Growth Denitrification	DENITR	Mechanical Aerator	16,300	MAS
		Turbine Mixer	7,750	MAS
		Pump	17,250	MAS
		Methanol	0.90	ENR
		Methanol Feed System	Parametric	EPA
Drying Beds	DRYING	4-in. Pipe	2.15	ENR
		6-in. Pipe	2.75	ENR
		8-in. Pipe	4.25	ENR
		Sand	5.90	ENR
		Gravel	4.30	ENR
Equalization	EQUALI	Floating Aerator	13,960	MAS
Filter Press	FLTR P	Capital Cost	Parametric	EPA
Filtration	FILTRA	Filter Unit	165,000	EPA
		Pump	17,250	MAS
		Package Filter Unit	Parametric	EPA
Flocculation	FLOCCU	Capital Cost	Parametric	EPA
Flotation	FLOTAT	Flotation Unit	44,200	MAS
Fluidized Bed Incineration	FLUIDI	Incinerator	1,100,000	MAS
		Fuel Oil	0.75	ENR
Gravity Thickening	GRAVIT	Thickener	82,500	MAS
Grit Removal	GRIT R	Capital Cost	Parametric	EPA
Sludge Hauling and Land Filling	HAULIN	Vehicle	51,700	MAS
Lagoon	LAGOON	Steel Pipe	12.80	MAS
		Butterfly Valve	952.10	MAS
Microscreening	MICROS	Microscreen	52,000	MAS
Multiple Hearth Incineration	MULTIP	Incinerator	1,190,000	MAS
		Fuel Oil	0.75	ENR
Neutralization	NEUTRA	Capital Cost	Parametric	EPA

Unit Processes	Key Word	Cost Item	1977 Cost Standard Equipment	Cost Index
Nitrification Suspended Growth	NITRIF	Mechanical Aerator	16,300	MAS
		Diffuser	6.50	MAS
		Swing Arm Diffuser	5,000	MAS
		Pump	17,250	MAS
		Diffuser Piping	Parametric	PIPE
Nitrification - RBC	N RBC	RBC Unit	34,500	MAS
Nitrification - Trickling Filter	N TRIC	Media	2.50	MAS
		Distributor Arm	39,000	MAS
		Pump	17,250	MAS
Overland Flow Land Treatment	OVERLA	Pump	17,250	MAS
		Steel Pipe	12.80	MAS
		Butterfly Valve	952.10	MAS
		Sprinkler	61.65	MAS
		Clearing & Grubbing	3,000	MAS
		Water Well	8.00	MAS
		Concrete Drainpipe	10.20	MAS
Oxidation Ditch	OXIDAT	Rotor Mechanism	15,340	MAS
		Pump	17,250	MAS
Postaeration	POST A	Mechanical Aerator	13,960	MAS
		Diffuser	6.50	MAS
		Swing Arm Diffuser	5,000	MAS
		Diffuser Piping	Parametric	PIPE
Belt Filtration	BELT F	Capital Cost	Parametric	EPA
Primary Clarification				
Primary	PRIMAR	Rectangular Mechanism	42,000	MAS
Two-Stage Lime	L PRIM	Circular Mechanism	75,000	MAS
Pumping	PUMPIN	Pump	17,250	MAS
Rapid Infiltration Land Treatment	RAPID	Steel Pipe	12.80	MAS
		Butterfly Valve	952.10	MAS
		PVC Pipe	6.94	MAS
		Concrete Drainpipe	10.20	MAS
		Water Well	8.00	MAS
		Pump	17,250	MAS
Raw Sewage Pumping	RAW SE	Pump	13,630	MAS
		Synchronous Motor	2,350	MAS
		Drive Module	11,500	MAS
Recarbonation	RECARB	Capital Cost	Parametric	EPA
First Stage Recarbonation	FIRST	Capital Cost	Parametric	EPA
Second Stage Recarbonation	SECOND	Capital Cost	Parametric	EPA
Rotating Biological Contactor	RBC	RBC Unit	30,500	MAS
		Pump	17,250	MAS
Screening	SCREEN	Capital Cost	Parametric	EPA

Unit Processes	Key Word	Cost Item	1977 Cost Standard Equipment	Cost Index
Secondary Clarification				
General	CLARIF	Rectangular Mechanism	42,000	MAS
Activated Sludge	A SECO	Circular Mechanism	75,000	MAS
Denitrification	D SECO			
Nitrification	N SECO			
Oxidation Ditch	O SECO			
Pure Oxygen	P SECO			
Trickling Filter	T SECO			
Slow Infiltration Land Treatment	SLOW I	Pump	17,250	MAS
		Steel Pipe	12.80	MAS
		Butterfly Valve	952.10	MAS
		Impact Sprinkler	61.65	MAS
		Clearing & Grubbing	3,000	MAS
		Water Well	8.00	MAS
		Sprinkler System	27,690	MAS
		PVC Pipe	6.94	MAS
Trickling Filter	TRICKL	Media	2.50	MAS
		Distributor Arm	39,000	MAS
		Pump	17,250	MAS
Vacuum Filtration	VACUUM	Vacuum Filter	150,000	MAS
Wet Oxidation	WET OX	Capital Cost	Parametric	EPA

b. Small system unit processes:

Unit Processes	Key Word	Cost Item	1977 Cost Standard Equipment	Cost Index
Activated Sludge	ACTIVA	Package Plant	36,500	MAS
Aerated Lagoon	AERAT	Mechanical Aerator	13,960	MAS
Bar Screens	SCREEN	Bar Screen Unit	10,350	MAS
Chlorination	CHLORI	Chlorine	100.00	ENR
		Chlorinator	2,700	MAS
Coagulation	COAGUL	Upflow Clarifier	110,000	MAS
Sludge Drying Beds	DRYING	6-in. Pipe	2.75	ENR
		Sand	5.90	ENR
		Gravel	4.30	ENR
Equalization	EQUALI	Floating Aerator	13,960	MAS
Filtration	FILTRA	Package Filter	73,760	MAS
Flotation	FLOTAT	Flotation Unit	44,200	MAS
Intermittent Sand Filter	INTERM	Sand	5.90	ENR
		Gravel	4.30	ENR
		6-in. Pipe	2.75	MAS
		Steel Pipe	12.80	MAS

Unit Processes	Key Word	Cost Item	1977 Cost Standard Equipment	Cost Index
Lagoon	LAGOON	Steel Pipe	12.80	MAS
		Butterfly Valve	952.10	MAS
Overland Flow Land Treatment	OVERLA	Pump	17,250	MAS
		Steel Pipe	12.80	MAS
		Butterfly Valve	952.10	MAS
		Sprinkler	61.65	MAS
		Clearing & Grubbing	3,000	MAS
		Water Well	8.00	MAS
		Concrete Drainpipe	10.20	MAS
Oxidation Ditch	OXIDAT	Brush Aerator	15,340	MAS
		Pump	17,250	MAS
Postaeration	POST A	Mechanical Aerator	13,960	MAS
		Diffuser	6.50	MAS
		Swing Arm Diffuser	5,000	MAS
		Diffuser Piping	Parametric	PIPE
Primary Clarifier	PRIMAR	Rectangular Mechanism	42,000	MAS
		Circular Mechanism	75,000	MAS
Pumping	PUMPIN	Pump	17,250	MAS
Rapid Infiltration Land Treatment	RAPID	Steel Pipe	12.80	MAS
		Butterfly Valve	952.10	MAS
		PVC Pipe	6.94	MAS
		Concrete Drainpipe	10.20	MAS
		Water Well	8.00	MAS
		Pump	17,250	MAS
Raw Sewage Pumping	RAW SE	Pump	2,800	MAS
Secondary Clarification				
Oxidation Ditch	O SECO	Rectangular Mechanism	42,000	MAS
Trickling Filter	T SECO	Circular Mechanism	75,000	MAS
Septic Tank and Tile Field	SEPTIC	6-in. Pipe	2.75	ENR
		Gravel	4.30	ENR
Slow Infiltration Land Treatment	SLOW I	Pump	17,250	MAS
		Steel Pipe	12.80	MAS
		Butterfly Valve	952.10	MAS
		Impact Sprinkler	61.65	MAS
		Clearing & Grubbing	3,000	MAS
		Water Well	8.00	MAS
		Sprinkler System	27,690	MAS
		PVC Pipe	6.94	MAS
Trickling Filter	TRICKL	Media	2.50	MAS
		Distributor Arm	39,000	MAS
		Pump	17,250	MAS

APPENDIX E

UPGRADING AND EXPANSION EXAMPLE PROBLEM OUTPUT

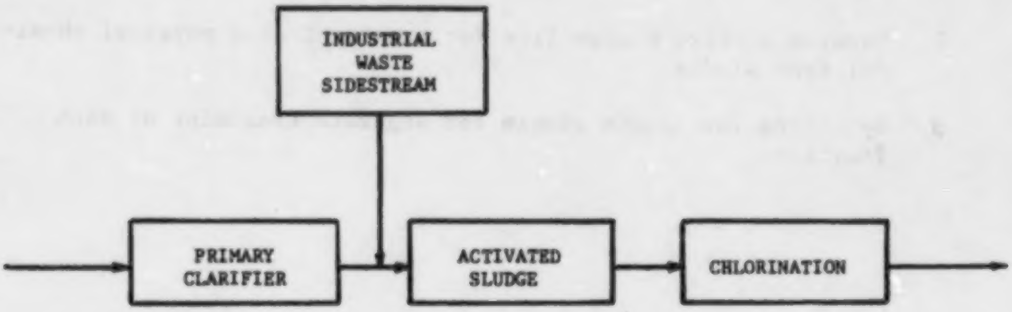
This section provides the user with several examples of the upgrading and expansion flow control functions. Space limitations do not permit the inclusion of examples for all possible combinations of the flow control options. Three examples have been formulated that represent treatment scenarios most often discussed by program users.

Examples chosen for presentation are as follows:

1. Introduction of a concentrated industrial waste side stream.
2. Forming a third sludge line for treatment of a physical chemical type sludge.
3. Splitting the liquid stream for separate treatment of each fraction.

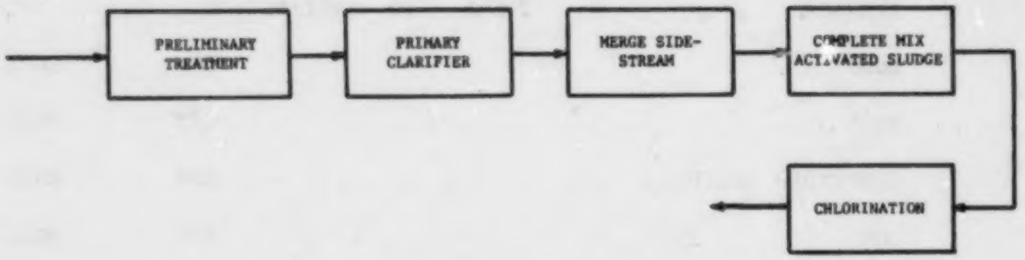
a. EXAMPLE 1: CONCENTRATED INDUSTRIAL WASTE SIDE STREAM.

Description: A typical problem in wastewater treatment may include the introduction of a concentrated industrial waste side stream at some point in the treatment process. In the example presented, an industrial waste side stream with primarily soluble waste constituents is to be jointly treated in a municipal wastewater treatment facility. Since the waste constituents are primarily soluble in nature, the side stream will be introduced downstream from the primary clarifier. In block diagram format the scenario presented may be described as follows.



(1) Refer to Chapter 5 for a discussion of the flow control functions. Refer to Appendix B for a discussion of the basic procedure for using CAPDET. The procedure for using CAPDET is the same as that found in Appendix B with the additions or modifications discussed below.

(2) As per STEP 1 of Appendix B, construct a CAPDET block diagram. The available treatment processes are augmented by the flow control functions. For simplicity of example, only coding of the liquid line will be considered. The sludge line will be the same as presented in Appendix B.


PRELIMINARY TREATMENT
PRIMARY CLARIFIER
MERGE SIDE-STREAM
COMPLETE MIX ACTIVATED SLUDGE
CHLORINATION

(3) Go to STEP 2 of Appendix B. For each treatment process or flow control function selected (list of treatment processes on page 2-11; flow control function on page 5-3), identify appropriate key words.

EXAMPLE:

Treatment Process or Flow Control Key Words	Associated Unit Process Key Words	Unit Process Name
PRELIM	GRIT R SCREEN COMMIN	Grit removal Bar screens Comminution
PRIMAR	PRIMAR	Primary clarification
L ME 1	None	None
COMPLE	COMPLE A SECO	Complete mix aeration Secondary clarification
CHLORI	CHLORI	Chlorination

(4) Perform STEP 3 of Appendix B. Since a side stream is specified, the characteristics of the side stream must be specified at this time. Assume for simplicity that only flow, BOD, and suspended solids are significant.

EXAMPLE:

```
L SIDE STREAM TANK 1
AVERAGE                   FINAL = 10  INITIAL = 5
BOD5                                     500      MG/L
SBOD                                     475      MG/L
SUSPENDED SOLIDS                         300      MG/L
COD                                      600      MG/L
SCOD                                     550      MG/L
END
```

(5) Perform STEP 4 of Appendix B.

(6) Perform STEP 5 of Appendix B referring to STEP 1 of this Appendix for scheme.

EXAMPLE:

```
LIQUID LINE
BLOCK     PRELIM
BLOCK     PRIMAR
L ME 1
BLOCK     COMPLE
BLOCK     CHLORI
SECONDARY SLUDGE LINE
BLOCK     A MIX
PRIMARY SLUDGE LINE
BLOCK     AEROBI ANAERO
BLOCK     DRYING
BLOCK     HAULIN
```

(7) Perform STEPS 6 through 9 of Appendix B.

(8) Assemble all data coded above and submit it to the CAPDET program.

EXAMPLE: The complete data list of example 1 above would be:

```
L SIDE STREAM TANK 1
AVERAGE             FINAL = 10   INITIAL = 5
BOD5                                     500
SBOD                                     475
SUSPENDED SOLIDS                         300
COD                                      600
SCOD                                     550
END
TITLE      SIDE STREAM MERGE EXAMPLE
LIQUID LINE
BLOCK      PRELIM
BLOCK      PRIMAR
L ME 1
BLOCK      COMPLE
BLOCK      CHLORI
SECONDARY SLUDGE LINE
BLOCK      A MIX
PRIMARY    SLUDGE LINE
BLOCK      AEROBI ANAERO
BLOCK      DRYING
BLOCK      HAULIN
WASTE INFLUENT
AVERAGE FLOW     FINAL = 10.0    INITIAL = 5.0          MGD
BOD5                                     300            MG/L
OIL AND GREASE                           0              MG/L
DESIRED EFFLUENT CHARACTERISTICS
UNIT COSTS
BUILDING                                 42.0           $/SQ FT
EXCAVATION                               1.75           $/CU YD
WALL CONCRETE                            275.0          $/CU YD
SLAB CONCRETE                            230.0          $/CU YD
MARSHALL AND SWIFT                       545.0
SMALL CITY EPA INDEX                     140.0
END
CONTROL CARDS
LIST                                     4              TRAINS
PRINT TRAIN NO 1
OUTPUT QUANTITIES
GO                     I = 6.625         YEARS = 30     CP = 3
```

```
L SIDE STREAM TANK 1
AVERAGE   10   5
BOD5      500
SBOD      475
COD       600
SCOD      550
SUSPENDED SOLIDS   300
END
TITLE   SIDE STREAM MERGE EXAMPLE
LIQUID LINE
BLOCK     PRELIM
BLOCK     PRIMAR
L ME 1
BLOCK     COMPLE
BLOCK     CHLORI
SECONDARY SLUDGE LINE
BLOCK     A MIX
PRIMARY SLUDGE LINE
BLOCK     AEROBI ANAERO
BLOCK     DRYING
BLOCK     HAULIN
WASTE INFLUENT
AVERAGE FLOW        10.0 MGD   QINIT  5.0 MGD
BOD5               300.0 MG/L
OIL AND GREASE       0.0 MG/L
DESIRED EFFLUENT CHARACTERISTICS
UNIT COSTS
BUILDING            42.00  $/SQFT
EXCAVATION           1.75  $/CUYD
WALL CONCRETE      275.00  $/CUYD
SLAB CONCRETE      230.00  $/CUYD
MARSHALL AND SWIFT 545.00
SMALL CITY EPA INDEX  140.00
END
CONTROL CARDS
LIST               4 TRAINS
PRINT TRAIN NO  1
OUTPUT QUANTITIES
GO        I=6.625     30 YEARS  CP=3 YEARS
```

```
                  COST ANALYSIS INPUT PARAMETERS
                   INTEREST RATE                        6.625 PERCENT
                   PLANNING PERIOD                         30 YEARS


      UNIT PRICES AND COSTS INDICES

    I BUILDING                                  42.00 $/SQFT
    I EXCAVATION                                 1.75 $/CUYD
    I WALL CONCRETE                            275.00 $/CUYD
    I SLAB CONCRETE                            230.00 $/CUYD
    I MARSHALL AND SWIFT INDEX                 545.00
    D CRANE RENTAL                              67.00 $/HR
    I EPA CONSTRUCTION COST INDEX              140.00
    D CANOPY ROOF                               15.75 $/SQFT
    D LABOR RATE                                13.40 $/HR
    D OPERATOR CLASS II                          7.50 $/HR
    D ELECTRICITY                                 .04 $/KWHR
    D CHEMICAL COSTS
        LIME                                      .03 $/LB
        ALUM                                      .04 $/LB
        IRON SALTS                                .06 $/LB
        POLYMER                                  1.62 $/LB
    D ENGINEERING NEWS RECORD COST INDEX      2886.00
    D HANDRAIL                                  25.20 $/FT
    D PIPE COST INDEX                          295.20
    D PIPE INSTALLATION LABOR RATE              14.70 $/HR
    D EIGHT INCH PIPE                            9.08 $/FT
    D EIGHT INCH PIPE BEND                      86.82 $/UNIT
    D EIGHT INCH PIPE TEE                      128.49 $/UNIT
    D EIGHT INCH PIPE VALVE                   1346.16 $/UNIT
```

```
   SIDE STREAM MERGE EXAMPLE

     PRESENT TRN    PROJECT TRN  CONSTRUCT TRN    O&M     TRN   ENERGY TRN
      WORTH   #      COST    #      COST    #     COST     #     COST   #
    36156574   1   22961427   2   16272246   2  1542758    2    896930   2
    39965553   2   25103300   1   17795148   1  1566019    1    920869   1

  TRAIN NO    1
  LIQUID     PREL  0  PRIM  0  L ME  1  COMP  0  CHLO  0
  SECONDARY A MI   0
  PRIMARY    AERO  0  DRYI  0  HAUL  0

  TRAIN NO    2
  LIQUID     PREL  0  PRIM  0  L ME  1  COMP  0  CHLO  0
  SECONDARY A MI   0
  PRIMARY    ANAE  0  DRYI  0  HAUL  0
```

```
SIDE STREAM MERGE EXAMPLE                              PRESENT    1  TRAIN NO    1
                                      INFLUENT


                                 LIQUID CHARACTERISTICS
FLOW        (MGD)      SOLIDS     (MG/L)                    (MG/L)           (MG/L)
MAXIMUM   10.0000      SUSPENDED  200.00        BOD5      300.00        TKN 45.00
AVERAGE   10.0000      VOLATILE     60.00 %     BOD5S      75.00        NH3 25.00
MINIMUM   10.0000      SETTLEABLE  15.00        COD       500.00        NO2   .00
                                                COD5      400.00        NO3   .00
TEMP (W)   10.0 C      OIL & GREASE       .00   PO4        18.00
TEMP (S)   23.0 C      CATIONS        160.00
PH           7.6       ANIONS         160.00

                                 SLUDGE CHARACTERISTICS
                                 PRIMARY           SECONDARY
   VOLUME (GAL/D)                   .00                 .00
     % SOLIDS                       .00                 .00
     % VOLATILE                     .00                 .00
```

```
SIDE STREAM MERGE EXAMPLE                            PRESENT    1  TRAIN NO    1

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

MECHANICALLY CLEANED BAR SCREEN

D BAR SIZE                                        .250+00 INCHES
D BAR SPACING                                     .150+01 INCHES
D SLOPE OF BARS FROM HORIZONTAL                   .300+02 DEG
  HEAD LOSS THROUGH SCREEN                        .206-01 FEET
D APPROACH VELOCITY                               .250+01 FT/SEC
D AVERAGE FLOW THROUGH VELOCITY                   .250+01 FT/SEC
D MAXIMUM FLOW THROUGH VELOCITY                   .300+01 FT/SEC
  SCREEN CHANNEL WIDTH                            .616+01 FEET
D AVERAGE CHANNEL DEPTH                           .100+01 FEET

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

```
  SIDE STREAM MERGE EXAMPLE                      PRESENT   1  TRAIN NO   1
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

  AERATED GRIT CHAMBER

  MAXIMUM FLOW                           .154+02 CFS
  AVERAGE FLOW                           .154+02 CFS
  MINIMUM FLOW                           .154+02 CFS
  TEMPERATURE                            .100+02 DEG C
D MAXIMUM FLOW THROUGH VELOCITY          .113+00 FPS
D AVERAGE FLOW THROUGH VELOCITY          .113+00 FPS
D SIZE SMALL. PART. 100% REMOVED         .200+00 MM
D SPECIFIC GRAVITY OF PARTICLE           .265+01
D NUMBER OF UNITS                        .200+01
  MAXIMUM FLOW/UNIT                      .770+01 CFS
D WIDTH OF CHANNEL                       .170+02 FEET
D DEPTH OF CHANNEL                       .400+01 FEET
  LENGTH OF CHANNEL                      .170+02 FEET
  SETTLING VELOCITY OF PARTICLE          .105+03 FPS
D DETENTION TIME                         .250+01 MIN
  VOLUME OF GRIT                         .400+02 CUFT/DAY
D AIR SUPPLY                             .300+01 CFM

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COMMINUTION

D NUMBER OF UNITS                        .200+01 UNITS
  DRUM DIAMETER                          .250+02 INCHES
  DRUM RPM                               .250+02 REV/MIN
  AVERAGE SLOT WIDTH                     .380+00 INCHES
  HORSEPOWER/UNIT                        .150+01 HP
  STANDARD HEIGHT                        .579+01 FEET
  STANDARD NET WEIGHT                    .210+04 POUNDS

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                         LIQUID CHARACTERISTICS
FLOW      (MGD)      SOLIDS     (MG/L)              (MG/L)        (MG/L)
MAXIMUM  10.0000     SUSPENDED  200.00     BOD5     300.00     TKN 65.00
AVERAGE  10.0000     VOLATILE    60.00 %   BOD5S     75.00     NH3 25.00
MINIMUM  10.0000     SETTLEABLE  15.00     COD      500.00     NO2   .00
                                           CODS     400.00     NO3   .00
TEMP (W)  10.0 C     OIL & GREASE    .00   PO4       18.00
TEMP (S)  23.0 C     CATIONS      160.00
PH           7.6     ANIONS       160.00


                         SLUDGE CHARACTERISTICS
                         PRIMARY          SECONDARY
   VOLUME (GAL/D)          .00              .00
     % SOLIDS              .00              .00
     % VOLATILE            .00              .00
  SIDE STREAM MERGE EXAMPLE                        PRESENT   1  TRAIN NO   1

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *


**** SUPERNATANT FROM SLUDGE LINE PROCESSES ADDED TO LIQUID LINE ****


                         LIQUID CHARACTERISTICS
FLOW       (MGD)      SOLIDS    (MG/L)              (MG/L)           (MG/L)
MAXIMUM  10.2000      SUSPENDED  262.75    BOD5    303.92       TKN 66.65
AVERAGE  10.2000      VOLATILE    60.00 %  BOD5S    75.98       NH3 24.51
MINIMUM  10.2000      SETTLEABLE  15.00    COD     541.18       NO2    .00
                                           CODS    432.94       NO3    .00
TEMP (W)   10.0 C     OIL & GREASE     .00 PO4      18.00
TEMP (S)   23.0 C     CATIONS      160.00
PH           7.6      ANIONS       160.00

                           SLUDGE CHARACTERISTICS
                           PRIMARY          SECONDARY
   VOLUME (GAL/D)              .00                .00
      % SOLIDS                 .00                .00
      % VOLATILE               .00                .00




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PRIMARY CLARIFIER

 CIRCULAR CLARIFIER

D SURFACE OVERFLOW RATE                 .100+04 GAL/DAY/SQFT
  SURFACE AREA                          .102+05 SQ FT
D SIDE WATER DEPTH                      .900+01 FEET
  DETENTION TIME                        .162+01 HOURS
  SOLID LOADING                         .219+01 LB/SQFT/DAY
D WEIR LOADING                          .150+05 GAL/DAY/FT
  WEIR LENGTH                           .680+03 FEET
  VOLUME OF SLUDGE PRODUCED             .370+05 GAL/DAY
D SUSPENDED SOLIDS REMOVAL              .580+02 PERCENT
D BOD REMOVAL                           .320+02 PERCENT
D COD REMOVAL                           .400+02 PERCENT
D TKN REMOVAL                           .500+01 PERCENT
D PO4 REMOVAL                           .500+01 PERCENT

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  SIDE STREAM MERGE EXAMPLE                         PRESENT   1  TRAIN NO   1

 QUANTITIES FOR SEDIMENTATION

 CIRCULAR CLARIFIER

 PRIMARY CLARIFIER
 EXCESS CAPACITY FACTOR                              .100+01
 CALCULATED SURFACE AREA                             .102+05 SQ FT
 ADJUSTED SURFACE AREA                               .102+05 SQ FT
 AVERAGE DAILY WASTEWATER FLOW                       .102+02 MGD
 NUMBER OF CIRCULAR CLARIFIERS                             4
 NUMBER OF BATTERIES                                       1
 SURFACE AREA PER UNIT                               .255+04 SQ FT
 DIAMETER OF UNIT                                    .570+02 FEET
 EARTHWORK REQUIRED                                  .125+06 CU FT
 SIDEWATER DEPTH                                     .900+01 FEET
 THICKNESS OF THE SLAB                               .101+02 INCHES
 WALL THICKNESS                                      .115+02 INCHES
 TOTAL  WALL CONCRETE REQUIRED                       .768+04 CU FT
 TOTAL SLAB CONCRETE REQUIRED                        .106+05 CU FT
 MAINTENANCE MANPOWER REQUIRED                       .570+03 MAN-HOURS/YR
 OPERATION MANPOWER REQUIRED                         .104+06 MAN-HOURS/YR
 ELECTRICAL ENERGY REQUIRED                          .101+05 KWHR/YR


                    LIQUID CHARACTERISTICS
 FLOW       (MGD)      SOLIDS    (MG/L)               (MG/L)         (MG/L)
 MAXIMUM  10.2000      SUSPENDED  110.35     BOD5     206.67      TKN 42.23
 AVERAGE  10.2000      VOLATILE    60.00 %   BOD5S     75.98      NH3 24.51
 MINIMUM  10.2000      SETTLEABLE    .00     COD      432.94      NO2   .00
                                             CODS     432.94      NO3   .00
 TEMP (W)  10.0 C      OIL & GREASE    .00   PO4       17.10
 TEMP (S)  23.0 C      CATIONS      160.00
 PH          7.6       ANIONS       160.00


                       SLUDGE CHARACTERISTICS
                        PRIMARY         SECONDARY
   VOLUME (GAL/D)      37009.52              .00
     % SOLIDS              4.00              .00
     % VOLATILE           60.00              .00


 *  * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

 TANK 1 MIXED INTO LIQUID LINE

 LIQUID LINE NOW CONTAINS:


                    LIQUID CHARACTERISTICS
 FLOW       (MGD)      SOLIDS    (MG/L)               (MG/L)         (MG/L)
 MAXIMUM  20.2000      SUSPENDED  204.24     BOD5     351.88      TKN 43.60
 AVERAGE  20.2000      VOLATILE    60.00 %   BOD5S    273.51      NH3 24.75
 MINIMUM  20.2000      SETTLEABLE   7.43     COD      515.64      NO2   .00
                                             CODS     490.89      NO3   .00
 TEMP (W)  10.0 C      OIL & GREASE  39.60   PO4       17.55
 TEMP (S)  23.0 C      CATIONS      160.00
 PH          7.6       ANIONS       160.00

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 SIDE STREAM MERGE EXAMPLE                              PRESENT   1  TRAIN NO   1

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COMPLETE MIX ACTIVATED SLUDGE

D REACTION RATE CONSTANT                  .135-02 L/MG-H
D SLUDGE PRODUCED PER BOD REMOVED         .730+00
D ENDOGENEOUS RATE  (OXYGEN BASIS)        .150+00 /DAY
D O2 UTILIZED PER BOD REMOVED             .520+00
D ENDOGENEOUS RATE  (SLUDGE BASIS)        .750-01 /DAY
D INFLUENT NON-DEGRADABLE VSS             .400+00
D EFFLUENT DEGRADABLE VSS                 .530+00
D LB BOD/LB MLSS-DAY                      .500+00
D MIXED LIQUOR SS                         .450+04 MG/L
D MIXED LIQUOR VS                         .315+04 MG/L
  AERATION TIME                           .113+02 HOURS
  VOLUME OF AERATION TANK                 .954+01 MG
  OXYGEN REQUIRED                         .741+05 LB/DAY
  SLUDGE PRODUCED                         .371+05 LB/DAY
  NITROGEN REQUIREMENT                    .171+02 MG/L
  PHOSPHOROUS REQUIREMENT                 .342+01 MG/L
  SLUDGE RECYCLE RATIO                    .818+02 PERCENT
  SOLIDS RETENTION TIME                   .966+01 DAYS
  VOLUMETRIC LOADING                      .465+02 LB BOD/TCFT

DIFFUSED AERATION SYSTEM

D STANDARD TRANSFEC EFFICIENCY            .600+01 PERCENT
  OPERATING EFFICIENCY                    .357+01 PERCENT
  REQUIRED AIR FLOW                       .642+02 CFM/TCFT

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 QUANTITIES FOR DIFFUSED AERATION SYSTEM

 COMPLETELY MIXED FLOW
 AVERAGE DAILY WASTEWATER FLOW                    .202+02 MGD
 TOTAL NUMBER OF TANKS                                  8
 NUMBER OF BATTERIES                                    1
 ACTUAL VOLUME PER TANK                           .160+06 CU FT
 PROCESS AIR REQUIREMENT                          .819+05 SCFM
 NUMBER OF DIFFUSERS PER TANK                         853
 NUMBER OF SWING ARM HEADERS PER TANK                  15
 LENGTH OF AERATION TANKS                         .354+03 FEET
 PIPE GALLERY WIDTH                               .281+02 FEET
 VOLUME OF EARTHWORK REQUIRED                     .664+06 CU FT
 REINFORCED SLAB CONCRETE REQUIRED                .199+06 CU FT
 REINFORCED WALL CONCRETE REQUIRED                .119+06 CU FT
 HANDRAIL LENGTH                                  .745+04 FEET
 OPERATION MANPOWER REQUIRED                      .793+04 MAN-HRS/YEAR
 MAINTENANCE MANPOWER REQUIRED                    .560+04 MAN-HRS/YEAR
 ELECTRICAL ENERGY REQUIRED                       .198+08 KWHR/YEAR
 O & M MATERIAL AND SUPPLY COST                   .163+01 PERCENT
```

```
  SIDE STREAM MERGE EXAMPLE                          PRESENT   1  TRAIN NO   1

 QUANTITIES FOR RECYCLE PUMPING

 AVERAGE DAILY PUMPING RATE                        .202+02 MGD
 TOTAL PUMPING CAPACITY                            .202+02 MGD
 DESIGN CAPACITY PER PUMP                          .701+04 GPM
 NUMBER OF PUMPS                                         3
 NUMBER OF BATTERIES                                     1
 AREA OF PUMP BUILDING                             .598+03 SQ FT
 VOLUME OF EARTHWORK REQUIRED                      .479+04 CU FT
 FIRM PUMPING CAPACITY                             .202+02 MGD
 OPERATING MANPOWER REQUIRED                       .806+03 MAN-HOURS/YR
 MAINTENANCE MANPOWER REQUIRED                     .677+03 MAN-HOURS/YR
 ELECTRICAL ENERGY REQUIRED                        .134+07 KWHR/YR
```

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SECONDARY CLARIFIER FOR ACTIVATED SLUDGE

 CIRCULAR CLARIFIER

  SOLIDS LOADING RATE                   .188+02 LB/SQFT/DAY
  SURFACE AREA                          .404+05 SQ FT
D SURFACE OVERFLOW RATE                 .500+03 GAL/SQFT/DAY
  DETENTION TIME                        .323+01 HOURS
D WEIR OVERFLOW RATE                    .150+05 GAL/FT/DAY
D TANK SIDEWATER DEPTH                  .900+01 FEET
  WEIR LENGTH                           .135+04 FEET
  VOLUME OF WASTED SLUDGE               .432+06 GAL/DAY
D UNDERFLOW CONCENTRATION               .100+01 PERCENT
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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  SIDE STREAM MERGE EXAMPLE                         PRESENT   1  TRAIN NO    1

GUANTITIES FOR SEDIMENTATION

CIRCULAR CLARIFIER

SECONDARY CLARIFIER
EXCESS CAPACITY FACTOR                              .100+01
CALCULATED SURFACE AREA                             .404+05 SQ FT
ADJUSTED SURFACE AREA                               .404+05 SQ FT
AVERAGE DAILY WASTEWATER FLOW                       .202+02 MGD
NUMBER OF CIRCULAR CLARIFIERS                             4
NUMBER OF BATTERIES                                       1
SURFACE AREA PER UNIT                               .101+05 SQ FT
DIAMETER OF UNIT                                    .114+03 FEET
EARTHWORK REQUIRED                                  .572+06 CU FT
SIDEWATER DEPTH                                     .900+01 FEET
THICKNESS OF THE SLAB                               .101+02 INCHES
WALL THICKNESS                                      .115+02 INCHES
TOTAL  WALL CONCRETE REQUIRED                       .149+05 CU FT
TOTAL SLAB CONCRETE REQUIRED                        .389+05 CU FT
MAINTENANCE MANPOWER REQUIRED                       .132+04 MAN-HOURS/YR
OPERATION MANPOWER REQUIRED                         .237+04 MAN-HOURS/YR
ELECTRICAL ENERGY REQUIRED                          .184+05 KWHR/YR


                              LIQUID CHARACTERISTICS
FLOW        (MGD)     SOLIDS      (MG/L)             (MG/L)        (MG/L)
MAXIMUM   20.2000     SUSPENDED    20.00    BOD5      15.34     TKN 30.52
AVERAGE   20.2000     VOLATILE     70.00 %  BOD5S     10.00     NH3 30.52
MINIMUM   20.2000     SETTLEABLE     .00    COD       23.01     NO2   .00
                                            CODS      15.00     NO3   .00
TEMP (W)   10.0 C     OIL & GREASE     .00  PO4       12.28
TEMP (S)   23.0 C     CATIONS       160.00
PH          7.6       ANIONS        160.00


                               SLUDGE CHARACTERISTICS
                                PRIMARY         SECONDARY
   VOLUME (GAL/D)              37009.52         431701.22
     % SOLIDS                      4.00              1.00
     % VOLATILE                   60.00             70.00



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CHLORINATION

  MAXIMUM FLOW                                  .202+02 MGD
  AVERAGE FLOW                                  .202+02 MGD
D CONTACT TIME                                  .300+02 MIN
  TOTAL VOLUME                                  .421+06 GAL
  AVERAGE CHLORINE REQUIREMENT                  .168+04 LB/DAY
  PEAK CHLORINE REQUIREMENT                     .168+04 LB/DAY
  COLIFORM REDUCTION                            .996+02 PERCENT

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  SIDE STREAM MERGE EXAMPLE                    PRESENT   1  TRAIN NO   1

QUANTITIES FOR CHLORINATION

NUMBER OF CHLORINATORS AND EVAPORATORS              1
CHLORINATION BUILDING AREA                     .220+03 SQ FT
NUMBER OF CHLORINE CYLINDERS                        26
AREA OF CHLORINE STORAGE BUILDING              .364+04 SQ FT
AVERAGE DAILY WASTEWATER FLOW MGD              .202+02 MGD
VOLUME OF EARTHWORK REQUIRED                   .269+05 CU FT
VOLUME OF WALL CONCRETE                        .932+04 CU FT
VOLUME OF SLAB CONCRETE                        .601+04 CU FT
CHLORINE REQUIREMENT PER YEAR                  .307+03 TONS/YR
OPERATIONAL LABOR                              .210+04 MAN-HOURS/YR
MAINTENANCE MANPOWER REQUIRED                  .718+03 MAN-HOURS/YR
ELECTRICAL ENERGY REQUIRED                     .151+06 KWHR/YR
CHLORINE REQUIREMENT                           .168+04 LBS/DAY
O & M MATERIAL AND SUPPLY COSTS                .265+01 PERCENT


                        LIQUID CHARACTERISTICS
FLOW        (MGD)      SOLIDS     (MG/L)              (MG/L)       (MG/L)
MAXIMUM   20.2000      SUSPENDED    20.00     BOD5      15.34     TKN 30.52
AVERAGE   20.2000      VOLATILE     70.00 %   BOD5S     10.00     NH3 30.52
MINIMUM   20.2000      SETTLEABLE     .00     COD       23.01     NO2   .00
                                              CODS      15.00     NO3   .00
TEMP (W)   10.0 C      OIL & GREASE     .00   PO4       12.28
TEMP (S)   23.0 C      CATIONS       160.00
PH           7.6       ANIONS        160.00

                         SLUDGE CHARACTERISTICS
                         PRIMARY          SECONDARY
   VOLUME (GAL/D)       37009.52          431701.22
      % SOLIDS              4.00               1.00
      % VOLATILE           60.00              70.00

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**** SECONDARY SLUDGE LINE MIXED INTO PRIMARY SLUDGE LINE ****


                               INFLUENT


                        LIQUID CHARACTERISTICS
FLOW        (MGD)      SOLIDS     (MG/L)              (MG/L)       (MG/L)
MAXIMUM   20.2000      SUSPENDED    20.00     BOD5      15.34     TKN 30.52
AVERAGE   20.2000      VOLATILE     70.00 %   BOD5S     10.00     NH3 30.52
MINIMUM   20.2000      SETTLEABLE     .00     COD       23.01     NO2   .00
                                              CODS      15.00     NO3   .00
TEMP (W)   10.0 C      OIL & GREASE     .00   PO4       12.28
TEMP (S)   23.0 C      CATIONS       160.00
PH           7.6       ANIONS        160.00

                         SLUDGE CHARACTERISTICS
                         PRIMARY          SECONDARY
   VOLUME (GAL/D)      468710.74                .00
      % SOLIDS              1.24                .00
      % VOLATILE           67.45                .00
  SIDE STREAM MERGE EXAMPLE                      PRESENT   1  TRAIN NO   1

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AEROBIC DIGESTION

  RAW SLUDGE SPECIFIC GRAVITY              .105+01
D DETENTION TIME                           .180+02 DAYS
D VOLATILE SOLIDS DESTROYED                .400+02 PERCENT
D MIXED LIQUOR SOLIDS                      .120+05 MG/L
D SOLIDS IN DIGESTED SLUDGE                .250+01 PERCENT
D ALPHA                                    .900+00
D BETA                                     .900+00
D STANDARD TRANSFER EFFICIENCY             .600+01 PERCENT
  DIGESTER VOLUME                          .844+07 GAL
  VOLATILE SOLIDS LOADING                  .304-01 LB VS/CUFT/DAY
  SOLIDS ACCUMULATED PER DAY               .278+05 LB/DAY
  DIGESTER CAPACITY                        .844+06 LB
  VOLUME OF WASTED SLUDGE                  .386+07 GAL
  SOLIDS RETENTION TIME                    .304+02 DAYS
  OXYGEN REQUIREMENT                       .274+05 LB/DAY
  AIR SUPPLY                               .272+02 CFM/TCFT

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QUANTITIES FOR DIFFUSED AERATION SYSTEM

COMPLETELY MIXED FLOW
AVERAGE DAILY WASTEWATER FLOW                      .469+00 MGD
TOTAL NUMBER OF TANKS                                    7
NUMBER OF BATTERIES                                      1
ACTUAL VOLUME PER TANK                             .161+06 CU FT
PROCESS AIR REQUIREMENT                            .306+05 SCFM
NUMBER OF DIFFUSERS PER TANK                          1277
NUMBER OF SWING ARM HEADERS PER TANK                    15
LENGTH OF AERATION TANKS                           .358+03 FEET
PIPE GALLERY WIDTH                                 .202+02 FEET
VOLUME OF EARTHWORK REQUIRED                       .592+06 CU FT
REINFORCED SLAB CONCRETE REQUIRED                  .177+06 CU FT
REINFORCED WALL CONCRETE REQUIRED                  .107+06 CU FT
HANDRAIL LENGTH                                    .675+04 FEET
OPERATION MANPOWER REQUIRED                        .483+04 MAN-HRS/YEAR
MAINTENANCE MANPOWER REQUIRED                      .309+04 MAN-HRS/YEAR
ELECTRICAL ENERGY REQUIRED                         .167+07 KWHR/YEAR
O & M MATERIAL AND SUPPLY COST                     .167+01 PERCENT


                        LIQUID CHARACTERISTICS
FLOW        (MGD)      SOLIDS     (MG/L)              (MG/L)        (MG/L)
MAXIMUM   20.2000      SUSPENDED    20.00     BOD5     15.34     TKN 30.52
AVERAGE   20.2000      VOLATILE     70.00 %   BOD5S    10.00     NH3 30.52
MINIMUM   20.2000      SETTLEABLE     .00     COD      23.01     NO2   .00
                                              CODS     15.00     NO3   .00
TEMP (W)   10.0 C      OIL & GREASE     .00   PO4      12.28
TEMP (S)   23.0 C      CATIONS     160.00
PH            7.6      ANIONS      160.00


                          SLUDGE CHARACTERISTICS
                          PRIMARY         SECONDARY
   VOLUME (GAL/D)       127000.15              .00
     % SOLIDS                2.50              .00
     % VOLATILE             55.42              .00
  SIDE STREAM MERGE EXAMPLE                        PRESENT   1  TRAIN NO   1

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SLUDGE DRYING BEDS

  TOTAL SURFACE AREA REQUIRED     .259+06 SQ FT
D INITIAL DEPTH OF SLUDGE         .120+02 INCHES
D FINAL PERCENT SOLIDS            .500+02
  BED HOLDING TIME                .152+02 DAYS

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QUANTITIES FOR DRYING BED

TOTAL DRYING BED SURFACE AREA                       .259+06 SQ FT
NUMBER BEDS                                              87
SURFACE AREA OF EACH INDIVIDUAL BED                 .297+04 SQ FT
LENGTH OF EACH BED                                  .149+03 FEET
VOLUME OF EARTHWORK REQUIRED                        .127+07 CU FT
VOLUME CONCRETE FOR DIVIDING WALL                   .838+05 CU FT
VOLUME OF R.C. IN-PLACE FOR TRUCK TRACKS            .388+05 CU FT
VOLUME OF SAND                                      .194+06 CU FT
VOLUME OF GRAVEL                                    .259+06 CU FT
CLAY PIPE DIAMETER                                  .600+01 INCHES
TOTAL LENGTH CLAY PIPE                              .259+05 FEET
SLUDGE SOLIDS PER DAY                               .132+02 TONS/DAY
OPERATION MANPOWER REQUIRED                         .141+05 MAN-HOURS/YR
MAINTENANCE MANPOWER REQUIRED                       .705+04 MAN-HOURS/YR


                         LIQUID CHARACTERISTICS
FLOW        (MGD)     SOLIDS     (MG/L)              (MG/L)        (MG/L)
MAXIMUM   20.2000     SUSPENDED   20.00      BOD5     15.34     TKN 30.52
AVERAGE   20.2000     VOLATILE    70.00 %    BOD5S    10.00     NH3 30.52
MINIMUM   20.2000     SETTLEABLE    .00      COD      23.01     NO2   .00
                                             CODS     15.00     NO3   .00
TEMP (W)   10.0 C     OIL & GREASE   .00     PO4      12.28
TEMP (S)   23.0 C     CATIONS     160.00
PH           7.6      ANIONS      160.00

                           SLUDGE CHARACTERISTICS
                           PRIMARY        SECONDARY
   VOLUME (GAL/D)          6350.01            .00
     % SOLIDS                50.00            .00
     % VOLATILE              55.42            .00
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 SIDE STREAM MERGE EXAMPLE                      PRESENT   1  TRAIN NO   1

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SLUDGE HAULING AND LAND FILLING

  VOLUME OF SLUDGE HAULED              .314+02 CUYD/DAY
  TRUCK CAPACITY                       .220+02 CU YD
D ROUND TRIP TIME TO DISPOSAL SITE     .100+01 HRS
D TRUCK LOADING TIME                   .750+00 HRS
D HOURS OF OPERATION PER DAY           .800+01 HRS
  NUMBER OF TRUCKS REQUIRED                  1
  TONS OF SLUDGE HAULED PER DAY        .278+02 TONS/DAY
D DISTANCE TO DISPOSAL SITE            .100+02 MILES

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *




QUANTITIES FOR SLUDGE HAULING AND LANDFILL

TOTAL SLUDGE VOLUME HAULED                        .314+02 CUYD/DAY
MAXIMUM ANTICIPATED LANDFILL DOWNTIME             .300+02 DAYS
ANTICIPATED SLUDGE STORAGE HEIGHT                 .800+01 FEET
SLUDGE STORAGE SHED AREA                          .318+04 SQ FT
WIDTH OF SLUDGE STORAGE SHED SLAB                 .399+02 FEET
LENGTH OF SLUDGE STORAGE SHED SLAB                .798+02 FFET
VOLUME OF EARTHWORK                               .873+04 CU FT
VOLUME OF SLAB CONCRETE                           .373+04 CU FT
SURFACE AREA OF CANOPY ROOF                       .318+04 SQ FT
DISTANCE TO DISPOSAL SITE                         .100+02 MILES
ROUND TRIP HAUL DISTANCE                          .200+02 MILES
TONS OF SLUDGE HAULED PER DAY                     .278+02 TONS/DAY
OPERATION MANPOWER REQUIRED                       .492+03 MAN-HOURS/YR
ROUND TRIPS PER DAY PER TRUCK                     .200+01
DISTANCE TRAVELED PER YEAR PER TRUCK              .100+05 MILES/YR
MAINTENANCE AND MATERIAL SUPPLY COST              .106+02 PERCENT


                           LIQUID CHARACTERISTICS
FLOW       (MGD)     SOLIDS     (MG/L)             (MG/L)        (MG/L)
MAXIMUM  20.2000     SUSPENDED   20.00     BOD5     15.34     TKN 30.52
AVERAGE  20.2000     VOLATILE    70.00 %   BOD5S    10.00     NH3 30.52
MINIMUM  20.2000     SETTLEABLE    .00     COD      23.01     NO2   .00
                                           CODS     15.00     NO3   .00
TEMP (W)  10.0 C     OIL & GREASE    .00   PO4      12.28
TEMP (S)  23.0 C     CATIONS      160.00
PH         7.6       ANIONS       160.00


                              SLUDGE CHARACTERISTICS
                              PRIMARY       SECONDARY
  VOLUME (GAL/D)                .00            .00
    % SOLIDS                    .00            .00
    % VOLATILE                  .00            .00
  SIDE STREAM MERGE EXAMPLE                        PRESENT   1  TRAIN NO   1

QUANTITIES FOR BLOWERS

DESIGN CAPACITY FOR BLOWER SYSTEM               .113+06 SCFM
NUMBER OF BLOWERS FOR MAX AIR REQUIREMENTS            2
CAPACITY OF INDIVIDUAL BLOWERS                  .563+05 SCFM
TOTAL NUMBER OF BLOWERS REQUIRED                      3
BLOWER BUILDING AREA                            .251+04 SQ FT
```

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  SIDE STREAM MERGE EXAMPLE                 PRESENT   1  TRAIN NO   1

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

LIQUID    PREL  0  PRIM  0  L ME  0  COMP  0  CHLO  0
SECONDARY A MI  0
PRIMARY   AERO  0  DRYI  0  HAUL  0

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                             COST SUMMARY

                                  OPER      MAINT                                           TOTAL
            CAPITAL    AMMORT     LABOR     LABOR      POWER    MATERIAL    CHEMICAL       O & M
  UNIT      COST       COST       COST      COST       COST       COST        COST         COST
              $        $/YR       $/YR      $/YR       $/YR       $/YR        $/YR         $/YR
PRELIMIN*   159346     11909      13915     6648       1859       3983           0        26205
PRIM CLA    522132     39025       7534     3851        605       5221           0        17211
COMP MIX   4419705    332994      57719    37782     791354      72178           0       959033
A SEC CL   1185456     88603      17255     8916        735      11854           0        38760
RCY PUMP    280690     23329       5662     4572      53746       1966           0        65146
CHLORINA    304168     24165      15287     4844       6039       8073       35923        70166
AERO DIG   3962707    298579      35168    20866      66728      66203           0       188965
DRY BEDS   1175592     89588     102716    47630          0      10580           0       160926
HAUL SLF    139809     18051       3577        0          0      14075           0        17652
BLOWERS    2436577    182114          0        0          0          0           0            0

SUB TOTAL 14586187   1108361     259035   134913     920869     194136           0      1544860

* WARNING - COST ESTIMATES ARE FROM PARAMETRIC EQUATIONS

DIRECT COSTS
 PROFIT/OVERHEAD                3208961 $

   SUB TOTAL (OTHER DIRECT)     3208961 $          TOTAL CONSTRUCTION COST  17795148 $

INDIRECT COSTS
 MISC NON CONST COSTS            689757 $
 ADMIN/LEGAL                     355902 $
 201 PLANNING                    622830 $
 A/E DESIGN FEE                 1015104 $
 INSPECTION                      355902 $
 CONTINGENCIES                  1623611 $
 TECHNICAL COSTS                 355902 $

   SUB TOTAL (INDIRECT)         5019008 $

LAND COSTS                        20000 $     (   20. ACRES)
INTEREST DURING CONSTRUCTION    2269144 $

ADMINISTRATIVE COST               28416 $/YR
LABORATORY COST                   28649 $/YR

 TOTAL PROJECT COST  25103300 $     TOTAL CONSTRUCTION COST  17795148 $
 FINAL YEAR O & M     1566019 $/YR  TOTAL STEP III COST      23465366 $
 INITIAL YEAR O & M   1105584 $/YR  PRESENT WORTH (APP. A)   42092119 $
```

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   SIDE STREAM MERGE EXAMPLE                          PRESENT   1  TRAIN NO   1

 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

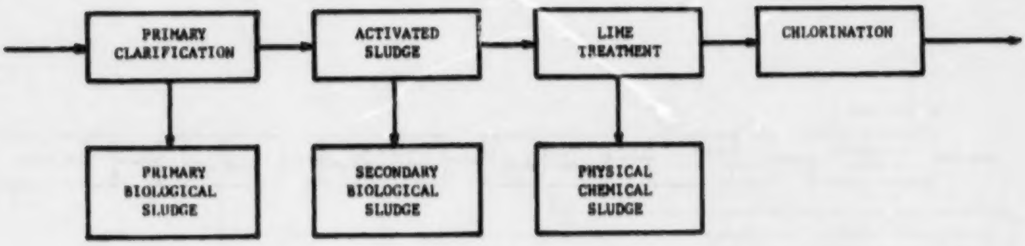
 USER CHARGE SUMMARY

 D EPA GRANT                                                .750+02 PERCENT
 D STATE GRANT                                              .000    PERCENT
 D ALLOWANCE FOR FINANCING                                  .300+01 PERCENT
   BONDS                 PERCENT  RATE  LIFE
 D   REVENUE              100.00 10.00   30
 D   GENERAL OBLIGATION      .00   .00   30
 D   OTHER                   .00   .00   30
 D EXISTING SEWER RATE                                      .000    $/TGAL
 D PERSONS PER HOUSEHOLD                                    .350+01
 D GALLONS/CAPITA/DAY (WATER USE)                           .100+03 GPCPD
   TOTAL PROJECT COST                                       .251+08 $
   EPA ELIGIBLE COST                                        .251+08 $
   LOCAL SHARE                                              .648+07 $
   ANNUAL DEBT SERVICE                                      .687+06 $/YEAR
   PRINCIPAL AND INTEREST RESERVE                           .982+05 $/YEAR
   CONTINGENCY RESERVE                                      .982+05 $/YEAR
   TOTAL ANNUAL OPERATING COST                              .245+07 $/YEAR
   TREATMENT COST
     COST PER 1000 GALLONS TREATED (NEW SYSTEM)             .671+00 $/TGAL
     COST PER 1000 GALLONS TREATED (TOTAL SYSTEM)           .671+00 $/TGAL
     COST PER BILLING UNIT (NEW SYSTEM)                     .134+01 $/TGAL
     COST PER BILLING UNIT (TOTAL SYSTEM)                   .134+01 $/TGAL
     COST PER HOUSEHOLD (NEW SYSTEM)                        .141+02 $/MONTH
     COST PER HOUSEHOLD (TOTAL SYSTEM)                      .141+02 $/MONTH
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

@XQT CAPDET.NEWPAGE
```

b. EXAMPLE 2: FORMING A THIRD SLUDGE LINE.

Description: A complex treatment scheme may produce primary biological sludges, secondary biological sludges, and physical chemical sludges. In such cases, it may be desirable to treat each separately or at least treat the primary and secondary biological sludges separately from the physical chemical sludges. An example of such a treatment scheme is the use of lime treatment for phosphorous removal after a conventional secondary treatment plant. In block diagram format, the scheme may be described by the following illustration.



Continuing development of this treatment scheme and for the sake of example, assume that one wishes to treat each sludge separately. This can be accomplished by using the STORE and RESTART functions discussed in Chapter 5.

For the sake of simplification, it will be assumed that default values will be used for all design values.

(1) Refer to Chapter 5 for a discussion of the flow control functions. Refer to Appendix B for a discussion of the basic procedure for using CAPDET. The procedure for using CAPDET is the same as that found in Appendix B with the additions or modifications discussed below.

(2) As per STEP 1 of Appendix B, construct a CAPDET block diagram. The available treatment processes (block cards) are augmented by the six flow control functions (Chapter 5). In order to construct the third sludge line, the sludges may be handled as follows:

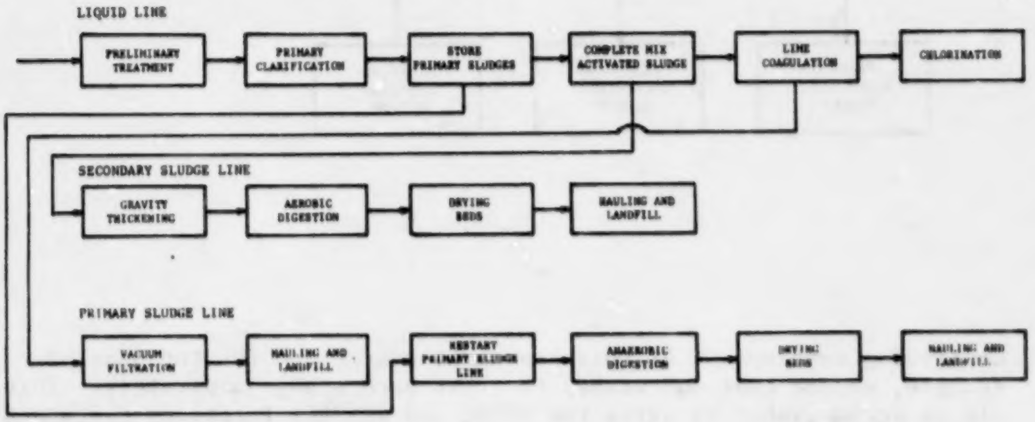
   (a) The physical chemical sludge may be treated on the primary sludge line.

(b) The secondary sludge can be treated on the secondary sludge line.

(c) The primary sludge can be treated on the secondary sludge or primary sludge line.

For this problem, treatment will be accomplished on the primary sludge. In order to accomplish this scheme, the primary sludge must be temporarily stored pending treatment of the physical chemical sludge.

EXAMPLE:


LIQUID LINE
PRELIMINARY TREATMENT
PRIMARY CLARIFICATION
STORE PRIMARY SLUDGES
COMPLETE MIX ACTIVATED SLUDGE
LIME COAGULATION
CHLORINATION
SECONDARY SLUDGE LINE
GRAVITY THICKENING
AEROBIC DIGESTION
DRYING BEDS
HAULING AND LANDFILL
PRIMARY SLUDGE LINE
VACUUM FILTRATION
HAULING AND LANDFILL
RESTART PRIMARY SLUDGE LINE
ANAEROBIC DIGESTION
DRYING BEDS
HAULING AND LANDFILL

(3) Go to STEP 2 of Appendix B. For each treatment process or flow control selected (list of treatment processes beginning on page 2-11; flow control function found on page 5-3) identify appropriate key words.

EXAMPLE:

Treatment Process or Flow Control Key Words	Associated Unit Process Key Words	Unit Process Name
LIQUID LINE		
PRELIM	GRIT R	Grit removal
	SCREEN	Bar screens
	COMMIN	Comminution
PRIMAR	PRIMAR	Primary clarification
P ST 1	None	None
COMPLE	COMPLE	Complet mix aeration
	A SECO	Secondary clarification
COAGUL	COAGUL	Coagulation and clarification
CHLORI	CHLORI	Chlorination
SECONDARY SLUDGE LINE		
GRAVIT	GRAVIT	Gravity thickening
AEROBI	AEROBI	Aerobic digestion
DRYING	DRYING	Drying beds
HAULIN	HAULIN	Hauling and landfill
PRIMARY SLUDGE LINE		
VACUUM	VACUUM	Vacuum filtration
HAULIN	HAULIN	Hauling and landfill
P RE 1	None	None
ANAERO	ANAERO	Anaerobic Digestion
DRYING	DRYING	Drying Beds
HAULIN	HAULIN	Hauling and landfill

(4) Perform STEP 3 of Appendix B.

(5) Perform STEP 4 of Appendix B.

(6) Perform STEP 5 of Appendix B referring to STEP 1 of this appendix for scheme.

EXAMPLE:

```
    LIQUID LINE
    BLOCK       PRELIM
    BLOCK       PRIMAR
    P ST 1
    BLOCK       COMPLE
    BLOCK       COAGUL
    BLOCK       CHLORI
    SECONDARY SLUDGE LINE
    BLOCK       GRAVIT
    BLOCK       AEROBI
    BLOCK       DRYING
    BLOCK       HAULIN
    PRIMARY SLUDGE LINE
    BLOCK       VACUUM
    BLOCK       HAULIN
    P RE 1
    BLOCK       ANAERO
    BLOCK       DRYING
    BLOCK       HAULIN
```

(7) Perform STEP 6 of Appendix B.

(8) Perform STEP 7 of Appendix B.

(9) Perform STEP 8 of Appendix B.

(10) Perform STEP 9 of Appendix B.

(11) Perform STEP 10 of Appendix B.

```
TITLE    FORMING A THIRD SLUDGE LINE
LIQUID LINE
BLOCK     PRELIM
BLOCK     PRIMAR
P ST 1
BLOCK     COMPLE
BLOCK     COAGUL
BLOCK     CHLORI
SECONDARY SLUDGE LINE
BLOCK     GRAVIT
BLOCK     AEROBI
BLOCK     DRYING
BLOCK     HAULIN
PRIMARY SLUDGE LINE
BLOCK     VACUUM
BLOCK     HAULIN
P RE 1
BLOCK     ANAERO
BLOCK     DRYING
BLOCK     HAULIN
WASTE INFLUENT
AVERAGE FLOW         10.0 MGD   QINIT  5.0 MGD
BOD5                300.0 MG/L
OIL AND GREASE        0.0 MG/L
DESIRED EFFLUENT CHARACTERISTICS
UNIT COSTS
BUILDING             42.00  $/SQFT
EXCAVATION            1.75  $/CUYD
WALL CONCRETE       275.00  $/CUYD
SLAB CONCRETE       230.00  $/CUYD
MARSHALL AND SWIFT 545.00
SMALL CITY EPA INDEX  140.00
END
CONTROL CARDS
LIST               4 TRAINS
PRINT TRAIN NO  1
OUTPUT QUANTITIES
GO              I=6.625     30 YEARS  CP=3 YEARS
```

```
                    COST ANALYSIS INPUT PARAMETERS
                         INTEREST RATE                      6.625 PERCENT
                         PLANNING PERIOD                       30 YEARS


  UNIT PRICES AND COSTS INDICES

I BUILDING                                    42.00 $/SQFT
I EXCAVATION                                   1.75 $/CUYD
I WALL CONCRETE                              275.00 $/CUYD
I SLAB CONCRETE                              230.00 $/CUYD
I MARSHALL AND SWIFT INDEX                   545.00
D CRANE RENTAL                                67.00 $/HR
I EPA CONSTRUCTION COST INDEX                140.00
D CANOPY ROOF                                 15.75 $/SQFT
D LABOR RATE                                  13.40 $/HR
D OPERATOR CLASS II                            7.50 $/HR
D ELECTRICITY                                   .04 $/KWHR
D CHEMICAL COSTS
   LIME                                         .03 $/LB
   ALUM                                         .04 $/LB
   IRON SALTS                                   .06 $/LB
   POLYMER                                     1.62 $/LB
D ENGINEERING NEWS RECORD COST INDEX        2886.00
D HANDRAIL                                    25.20 $/FT
D PIPE COST INDEX                            295.20
D PIPE INSTALLATION LABOR RATE                14.70 $/HR
D EIGHT INCH PIPE                              9.08 $/FT
D EIGHT INCH PIPE BEND                        86.82 $/UNIT
D EIGHT INCH PIPE TEE                        128.49 $/UNIT
D EIGHT INCH PIPE VALVE                     1346.16 $/UNIT




  FORMING A THIRD SLUDGE LINE

   PRESENT TRN    PROJECT TRN  CONSTRUCT TRN   O&M    TRN   ENERGY TRN
    WORTH   #      COST    #     COST     #    COST    #     COST   #
  29530424   1   16285877   1   11526355   1  1590618   1   327815   1

TRAIN NO    1
LIQUID     PREL  0  PRIM  0  P ST  1  COMP  0  COAG  0  CHLO  0
SECONDARY  GRAV  0  AERO  0  DRYI  0  HAUL  0
PRIMARY    VACU  0  HAUL  0  P RE  1  ANAE  0  DRYI  0  HAUL  0
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   FORMING A THIRD SLUDGE LINE                    PRESENT    1  TRAIN NO    1

                                 INFLUENT


                          LIQUID CHARACTERISTICS
FLOW         (MGD)      SOLIDS     (MG/L)                (MG/L)       (MG/L)
MAXIMUM    10.0000      SUSPENDED  200.00      BOD5      300.00     TKN 45.00
AVERAGE    10.0000      VOLATILE    60.00 %    BOD5S      75.00     NH3 25.00
MINIMUM    10.0000      SETTLEABLE  15.00      COD       500.00     NO2   .00
                                               CODS      400.00     NO3   .00
TEMP (W)    10.0 C      OIL & GREASE      .00  PO4        18.00
TEMP (S)    23.0 C      CATIONS        160.00
PH           7.6        ANIONS         160.00

                          SLUDGE CHARACTERISTICS
                          PRIMARY            SECONDARY
   VOLUME (GAL/D)           .00                  .00
     % SOLIDS               .00                  .00
     % VOLATILE             .00                  .00
```

```
   FORMING A THIRD SLUDGE LINE                    PRESENT    1  TRAIN NO    1

 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

 MECHANICALLY CLEANED BAR SCREEN

 D BAR SIZE                                       .250+00 INCHES
 D BAR SPACING                                    .150+01 INCHES
 D SLOPE OF BARS FROM HORIZONTAL                  .300+02 DEG
   HEAD LOSS THROUGH SCREEN                       .206-01 FEET
 D APPROACH VELOCITY                              .250+01 FT/SEC
 D AVERAGE FLOW THROUGH VELOCITY                  .250+01 FT/SEC
 D MAXIMUM FLOW THROUGH VELOCITY                  .300+01 FT/SEC
   SCREEN CHANNEL WIDTH                           .616+01 FEET
 D AVERAGE CHANNEL DEPTH                          .100+01 FEET

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  FORMING A THIRD SLUDGE LINE                     PRESENT   1  TRAIN NO   1

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

  AERATED GRIT CHAMBER

  MAXIMUM FLOW                              .154+02 CFS
  AVERAGE FLOW                              .154+02 CFS
  MINIMUM FLOW                              .154+02 CFS
  TEMPERATURE                               .100+02 DEG C
D MAXIMUM FLOW THROUGH VELOCITY             .113+00 FPS
D AVERAGE FLOW THROUGH VELOCITY             .113+00 FPS
D SIZE SMALL. PART. 100% REMOVED            .200+00 MM
D SPECIFIC GRAVITY OF PARTICLE              .265+01
D NUMBER OF UNITS                           .200+01
  MAXIMUM FLOW/UNIT                         .770+01 CFS
D WIDTH OF CHANNEL                          .170+02 FEET
D DEPTH OF CHANNEL                          .400+01 FEET
  LENGTH OF CHANNEL                         .170+02 FEET
  SETTLING VELOCITY OF PARTICLE             .105+03 FPS
D DETENTION TIME                            .250+01 MIN
  VOLUME OF GRIT                            .400+02 CUFT/DAY
D AIR SUPPLY                                .300+01 CFM

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  FORMING A THIRD SLUDGE LINE                     PRESENT   1  TRAIN NO   1

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COMMINUTION

D NUMBER OF UNITS                            .200+01 UNITS
  DRUM DIAMETER                              .250+02 INCHES
  DRUM RPM                                   .250+02 REV/MIN
  AVERAGE SLOT WIDTH                         .380+00 INCHES
  HORSEPOWER/UNIT                            .150+01 HP
  STANDARD HEIGHT                            .579+01 FEET
  STANDARD NET WEIGHT                        .210+04 POUNDS

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                        LIQUID CHARACTERISTICS
FLOW        (MGD)      SOLIDS    (MG/L)               (MG/L)       (MG/L)
MAXIMUM   10.0000      SUSPENDED  200.00    BOD5     300.00    TKN 45.00
AVERAGE   10.0000      VOLATILE    60.00 %  BOD5S     75.00    NH3 25.00
MINIMUM   10.0000      SETTLEABLE  15.00    COD      500.00    NO2   .00
                                            CODS     400.00    NO3   .00
TEMP (W)   10.0 C      OIL & GREASE    .00  PO4       18.00
TEMP (S)   23.0 C      CATIONS      160.00
PH          7.6        ANIONS       160.00


                          SLUDGE CHARACTERISTICS
                          PRIMARY        SECONDARY
    VOLUME (GAL/D)          .00             .00
      % SOLIDS              .00             .00
      % VOLATILE            .00             .00
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   FORMING A THIRD SLUDGE LINE                     PRESENT   1  TRAIN NO   1

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**** SUPERNATANT FROM SLUDGE LINE PROCESSES ADDED TO LIQUID LINE ****

                         LIQUID CHARACTERISTICS
FLOW       (MGD)      SOLIDS     (MG/L)           (MG/L)          (MG/L)
MAXIMUM  10.4000      SUSPENDED  377.88     BOD5   317.31     TKN 61.87
AVERAGE  10.4000      VOLATILE    60.00 %   BOD5S   79.33     NH3 36.54
MINIMUM  10.4000      SETTLEABLE  15.00     COD    572.12     NO2   .00
                                            CODS   457.69     NO3   .00
TEMP (W)  10.0 C      OIL & GREASE    .00   PO4     18.00
TEMP (S)  23.0 C      CATIONS      160.00
PH          7.6       ANIONS       160.00

                            SLUDGE CHARACTERISTICS
                            PRIMARY           SECONDARY
   VOLUME (GAL/D)              .00                .00
      % SOLIDS                 .00                .00
      % VOLATILE               .00                .00
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   FORMING A THIRD SLUDGE LINE                     PRESENT   1  TRAIN NO   1

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PRIMARY CLARIFIER

 CIRCULAR CLARIFIER

D SURFACE OVERFLOW RATE                   .100+04 GAL/DAY/SQFT
  SURFACE AREA                            .104+05 SQ FT
D SIDE WATER DEPTH                        .900+01 FEET
  DETENTION TIME                          .162+01 HOURS
  SOLID LOADING                           .315+01 LB/SQFT/DAY
D WEIR LOADING                            .150+05 GAL/DAY/FT
  WEIR LENGTH                             .693+03 FEET
  VOLUME OF SLUDGE PRODUCED               .543+05 GAL/DAY
D SUSPENDED SOLIDS REMOVAL                .580+02 PERCENT
D BOD REMOVAL                             .320+02 PERCENT
D COD REMOVAL                             .400+02 PERCENT
D TKN REMOVAL                             .500+01 PERCENT
D PO4 REMOVAL                             .500+01 PERCENT

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   FORMING A THIRD SLUDGE LINE                        PRESENT   1  TRAIN NO    1

QUANTITIES FOR SEDIMENTATION

CIRCULAR CLARIFIER

PRIMARY CLARIFIER
EXCESS CAPACITY FACTOR                         .100+01
CALCULATED SURFACE AREA                        .104+05 SQ FT
ADJUSTED SURFACE AREA                          .104+05 SQ FT
AVERAGE DAILY WASTEWATER FLOW                  .104+02 MGD
NUMBER OF CIRCULAR CLARIFIERS                        4
NUMBER OF BATTERIES                                  1
SURFACE AREA PER UNIT                          .260+04 SQ FT
DIAMETER OF UNIT                               .580+02 FEET
EARTHWORK REQUIRED                             .129+06 CU FT
SIDEWATER DEPTH                                .900+01 FEET
THICKNESS OF THE SLAB                          .101+02 INCHES
WALL THICKNESS                                 .115+02 INCHES
TOTAL  WALL CONCRETE REQUIRED                  .781+04 CU FT
TOTAL SLAB CONCRETE REQUIRED                   .107+05 CU FT
MAINTENANCE MANPOWER REQUIRED                  .577+03 MAN-HOURS/YR
OPERATION MANPOWER REQUIRED                    .105+04 MAN-HOURS/YR
ELECTRICAL ENERGY REQUIRED                     .102+05 KWHR/YR


                          LIQUID CHARACTERISTICS
FLOW        (MGD)      SOLIDS     (MG/L)              (MG/L)         (MG/L)
MAXIMUM  10.4000       SUSPENDED  158.71      BOD5    215.77      TKN 58.77
AVERAGE  10.4000       VOLATILE    60.00 %    BOD5S    79.33      NH3 36.54
MINIMUM  10.4000       SETTLEABLE    .00      COD     457.69      NO2    .00
                                              CODS    457.69      NO3    .00
TEMP (W)  10.0 C       OIL & GREASE     .00   PO4      17.10
TEMP (S)  23.0 C       CATIONS       160.00
PH          7.6        ANIONS        160.00

                          SLUDGE CHARACTERISTICS
                          PRIMARY          SECONDARY
   VOLUME (GAL/D)        54271.42               .00
     % SOLIDS                4.00               .00
     % VOLATILE             60.00               .00


   FORMING A THIRD SLUDGE LINE                        PRESENT   1  TRAIN NO    1
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100.0 PERCENT OF PRIMARY SLUDGE LINE STORED IN SLUDGE TANK 1

        .0 GAL/D REMAINS IN THE PRIMARY SLUDGE LINE

SLUDGE TANK 1 NOW CONTAINS:

                          SLUDGE CHARACTERISTICS
                          VOLUME (GAL/D)       54271.42
                            % SOLIDS               4.00
                            % VOLATILE            60.00

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   FORMING A THIRD SLUDGE LINE                          PRESENT   1  TRAIN NO   1

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COMPLETE MIX ACTIVATED SLUDGE

D REACTION RATE CONSTANT                  .135-02 L/MG-H
D SLUDGE PRODUCED PER BOD REMOVED         .730+00
D ENDOGENEOUS RATE  (OXYGEN BASIS)        .150+00 /DAY
D O2 UTILIZED PER BOD REMOVED             .520+00
D ENDOGENEOUS RATE  (SLUDGE BASIS)        .750-01 /DAY
D INFLUENT NON-DEGRADABLE VSS             .400+00
D EFFLUENT DEGRADABLE VSS                 .530+00
D LB BOD/LB MLSS-DAY                      .500+00
D MIXED LIQUOR SS                         .450+04 MG/L
D MIXED LIQUOR VS                         .315+04 MG/L
  AERATION TIME                           .683+01 HOURS
  VOLUME OF AERATION TANK                 .296+01 MG
  OXYGEN REQUIRED                         .234+05 LB/DAY
  SLUDGE PRODUCED                         .127+05 LB/DAY
  NITROGEN REQUIREMENT                    .103+02 MG/L
  PHOSPHOROUS REQUIREMENT                 .206+01 MG/L
  SLUDGE RECYCLE RATIO                    .818+02 PERCENT
  SOLIDS RETENTION TIME                   .871+01 DAYS
  VOLUMETRIC LOADING                      .473+02 LB BOD/TCFT

DIFFUSED AERATION SYSTEM

D STANDARD TRANSFER EFFICIENCY            .600+01 PERCENT
  OPERATING EFFICIENCY                    .357+01 PERCENT
  REQUIRED AIR FLOW                       .654+02 CFM/TCFT

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   FORMING A THIRD SLUDGE LINE                          PRESENT   1  TRAIN NO   1

QUANTITIES FOR DIFFUSED AERATION SYSTEM

COMPLETELY MIXED FLOW
AVERAGE DAILY WASTEWATER FLOW                      .104+02 MGD
TOTAL NUMBER OF TANKS                                    6
NUMBER OF BATTERIES                                      1
ACTUAL VOLUME PER TANK                             .659+05 CU FT
PROCESS AIR REQUIREMENT                            .259+05 SCFM
NUMBER OF DIFFUSERS PER TANK                           360
NUMBER OF SWING ARM HEADERS PER TANK                     6
LENGTH OF AERATION TANKS                           .146+03 FEET
PIPE GALLERY WIDTH                                 .242+02 FFET
VOLUME OF EARTHWORK REQUIRED                       .233+06 CU FT
REINFORCED SLAB CONCRETE REQUIRED                  .853+05 CU FT
REINFORCED WALL CONCRETE REQUIRED                  .447+05 CU FT
HANDRAIL LENGTH                                    .262+04 FEET
OPERATION MANPOWER REQUIRED                        .444+04 MAN-HRS/YEAR
MAINTENANCE MANPOWER REQUIRED                      .279+04 MAN-HRS/YEAR
ELECTRICAL ENERGY REQUIRED                         .625+07 KWHR/YEAR
O & M MATERIAL AND SUPPLY COST                     .194+01 PERCENT
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   FORMING A THIRD SLUDGE LINE                    PRESENT   1  TRAIN NO   1

  QUANTITIES FOR RECYCLE PUMPING

  AVERAGE DAILY PUMPING RATE                      .104+02 MGD
  TOTAL PUMPING CAPACITY                          .104+02 MGD
  DESIGN CAPACITY PER PUMP                        .361+04 GPM
  NUMBER OF PUMPS                                       3
  NUMBER OF BATTERIES                                   1
  AREA OF PUMP BUILDING                           .405+03 SQ FT
  VOLUME OF EARTHWORK REQUIRED                    .324+04 CU FT
  FIRM PUMPING CAPACITY                           .104+02 MGD
  OPERATING MANPOWER REQUIRED                     .645+03 MAN-HOURS/YR
  MAINTENANCE MANPOWER REQUIRED                   .546+03 MAN-HOURS/YR
  ELECTRICAL ENERGY REQUIRED                      .693+06 KWHR/YR
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   FORMING A THIRD SLUDGE LINE                    PRESENT   1  TRAIN NO   1

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 SECONDARY CLARIFIER FOR ACTIVATED SLUDGE

  CIRCULAR CLARIFIER

   SOLIDS LOADING RATE                   .188+02 LB/SQFT/DAY
   SURFACE AREA                          .208+05 SQ FT
 D SURFACE OVERFLOW RATE                 .500+03 GAL/SQFT/DAY
   DETENTION TIME                        .323+01 HOURS
 D WEIR OVERFLOW RATE                    .150+05 GAL/FT/DAY
 D TANK SIDEWATER DEPTH                  .900+01 FEET
   WEIR LENGTH                           .693+03 FEET
   VOLUME OF WASTED SLUDGE               .148+06 GAL/DAY
 D UNDERFLOW CONCENTRATION               .100+01 PERCENT

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  FORMING A THIRD SLUDGE LINE                    PRESENT   1  TRAIN NO    1

QUANTITIES FOR SEDIMENTATION

CIRCULAR CLARIFIER

SECONDARY CLARIFIER
EXCESS CAPACITY FACTOR                              .100+01
CALCULATED SURFACE AREA                             .208+05 SQ FT
ADJUSTED SURFACE AREA                               .208+05 SQ FT
AVERAGE DAILY WASTEWATER FLOW                       .104+02 MGD
NUMBER OF CIRCULAR CLARIFIERS                             4
NUMBER OF BATTERIES                                       1
SURFACE AREA PER UNIT                               .520+04 SQ FT
DIAMETER OF UNIT                                    .820+02 FEET
EARTHWORK REQUIRED                                  .270+06 CU FT
SIDEWATER DEPTH                                     .900+01 FEET
THICKNESS OF THE SLAB                               .101+02 INCHES
WALL THICKNESS                                      .115+02 INCHES
TOTAL  WALL CONCRETE REQUIRED                       .108+05 CU FT
TOTAL SLAB CONCRETE REQUIRED                        .206+05 CU FT
MAINTENANCE MANPOWER REQUIRED                       .881+03 MAN-HOURS/YR
OPERATION MANPOWER REQUIRED                         .159+06 MAN-HOURS/YR
ELECTRICAL ENERGY REQUIRED                          .125+05 KWHR/YR


                         LIQUID CHARACTERISTICS
FLOW        (MGD)      SOLIDS     (MG/L)            (MG/L)        (MG/L)
MAXIMUM   10.4000      SUSPENDED    20.00    BOD5     15.36     TKN 61.16
AVERAGE   10.4000      VOLATILE     70.00 %  BOD5S    10.00     NH3 61.16
MINIMUM   10.4000      SETTLEABLE     .00    COD      23.01     NO2   .00
                                             CODS     15.00     NO3   .00
TEMP (W)   10.0 C      OIL & GREASE    .00   PO4      11.97
TEMP (S)   23.0 C      CATIONS      160.00
PH            7.6      ANIONS       160.00


                          SLUDGE CHARACTERISTICS
                          PRIMARY         SECONDARY
   VOLUME (GAL/D)           .00           148313.84
     % SOLIDS               .00                1.00
     % VOLATILE             .00               70.00



   FORMING A THIRD SLUDGE LINE                   PRESENT   1  TRAIN NO   1

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COAGULATION

D LIME DOSAGE                           .250+03 MG/L
D OPTIMUM PH                            .105+02
  COAGULANT REQUIREMENT                 .217+05 LB/DAY

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FORMING A THIRD SLUDGE LINE                       PRESENT    1  TRAIN NO    1

 QUANTITIES FOR CHEMICAL COAGULATION

AVERAGE DAILY WASTEWATER FLOW                    .104+02 MGD
NUMBER OF UPFLOW CLARIFIERS PER BATTERY                4
NUMBER OF BATTERIES                                    1
WASTEWATER TO BE HANDLED BY ONE UNIT             .260+01 MGD
DESIGN OVERFLOW RATE DEPENDENT ON COAGULANT      .630+03 GPD/SQFT
SURFACE AREA OF EACH INDIVIDUAL UNIT             .413+04 SQFT
DIAMETER OF UNIT                                 .725+02 FEET
SIDE WATER DEPTH                                 .155+02 FEET
EARTHWORK REQUIRED                               .207+06 CU FT
THICKNESS OF SLAB                                .118+02 INCHES
WALL  THICKNESS                                  .149+02 INCHES
TOTAL  WALL CONCRETE REQUIRED                    .196+05 CU FT
TOTAL  SLAB CONCRETE REQUIRED                    .190+05 CU FT
MECHANISM HORSEPOWER INSTALLED                   .331+01 HP
ELECTRICAL ENERGY REQUIRED                       .887+05 KWHR/YR
OPERATIONAL MANPOWER                             .423+04 MAN-HOURS/YR
MAINTENANCE MANPOWER                             .158+04 MAN-HOURS/YR


                        LIQUID CHARACTERISTICS
FLOW        (MGD)      SOLIDS    (MG/L)               (MG/L)        (MG/L)
MAXIMUM   10.4000      SUSPENDED    2.00     BOD5      10.00      TKN 41.14
AVERAGE   10.4000      VOLATILE    70.00 %   BOD5S     10.00      NH3 41.14
MINIMUM   10.4000      SETTLEABLE    .00     COD       15.00      NO2    .00
                                             CODS      15.00      NO3    .00
TEMP (W)   10.0 C      OIL & GREASE   .00    PO4        5.98
TEMP (S)   23.0 C      CATIONS     160.00
PH          10.5       ANIONS      160.00

                          SLUDGE CHARACTERISTICS
                          PRIMARY          SECONDARY
   VOLUME (GAL/D)        77851.43          148313.84
     % SOLIDS                5.00               1.00
     % VOLATILE             70.00              70.00
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   FORMING A THIRD SLUDGE LINE                     PRESENT    1  TRAIN NO    1

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CHLORINATION

  MAXIMUM FLOW                                 .104+02 MGD
  AVERAGE FLOW                                 .104+02 MGD
D CONTACT TIME                                 .300+02 MIN
  TOTAL VOLUME                                 .217+06 GAL
  AVERAGE CHLORINE REQUIREMENT                 .867+03 LB/DAY
  PEAK CHLORINE REQUIREMENT                    .867+03 LB/DAY
  COLIFORM REDUCTION                           .996+02 PERCENT

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   FORMING A THIRD SLUDGE LINE                        PRESENT   1  TRAIN NO   1

QUANTITIES FOR CHLORINATION

NUMBER OF CHLORINATORS AND EVAPORATORS                     1
CHLORINATION BUILDING AREA                         .220+03 SQ FT
NUMBER OF CHLORINE CYLINDERS                              14
AREA OF CHLORINE STORAGE BUILDING                  .196+04 SQ FT
AVERAGE DAILY WASTEWATER FLOW MGD                  .104+02 MGD
VOLUME OF EARTHWORK REQUIRED                       .149+05 CU FT
VOLUME OF WALL CONCRETE                            .581+04 CU FT
VOLUME OF SLAB CONCRETE                            .319+04 CU FT
CHLORINE REQUIREMENT PER YEAR                      .158+03 TONS/YR
OPERATIONAL LABOR                                  .148+04 MAN-HOURS/YR
MAINTENANCE MANPOWER REQUIRED                      .377+03 MAN-HOURS/YR
ELECTRICAL ENERGY REQUIRED                         .132+06 KWHR/YR
CHLORINE REQUIREMENT                               .867+03 LBS/DAY
O & M MATERIAL AND SUPPLY COSTS                    .310+01 PERCENT


                       LIQUID CHARACTERISTICS
FLOW       (MGD)      SOLIDS    (MG/L)              (MG/L)        (MG/L)
MAXIMUM  10.4000      SUSPENDED      2.00   BOD5     10.00     TKN 41.14
AVERAGE  10.4000      VOLATILE      70.00 %  BOD5S    10.00     NH3 41.14
MINIMUM  10.4000      SETTLEABLE      .00   COD      15.00     NO2   .00
                                            CODS     15.00     NO3   .00
TEMP (W)  10.0 C      OIL & GREASE    .00   PO4       5.98
TEMP (S)  23.0 C      CATIONS      160.00
PH          10.5      ANIONS       160.00


                        SLUDGE CHARACTERISTICS
                         PRIMARY        SECONDARY
  VOLUME (GAL/D)        77851.43        148313.84
     % SOLIDS               5.00             1.00
     % VOLATILE            70.00            70.00


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GRAVITY THICKENING

   AVERAGE SLUDGE FLOW                    .148+00 MGD
   INITIAL CONCENTRATION                  .100+01 PERCENT
 D THICKENED CONCENTRATION                .500+01 PERCENT
 D MASS LOADING                           .100+02 LB/SQFT/DAY
   HYDRAULIC LOADING                      .120+03 GAL/DAY/SQFT


   DETENTION TIME                         .135+02 HOURS


   NUMBER OF UNITS                        .200+01
 D DEPTH                                  .900+01 FEET
   VOLUME                                 .111+05 CU FT
   SURFACE AREA PER TANK                  .618+03 SQ FT
   VOLUME OF THICKENED SLUDGE             .254+05 GAL/DAY

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****NOTE-RECIRCULATION REQUIRED TO PREVENT
            ANAEROBIC CONDITIONS

****NOTE-DETENTION TIME GREATER THAN SIX HOURS
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   FORMING A THIRD SLUDGE LINE                       PRESENT    1  TRAIN NO    1

QUANTITIES FOR GRAVITY THICKENING

SURFACE AREA PER TANK                               .618+03 SQ FT
DIAMETFR TANK                                       .290+02 FEET
NO UNITS                                                  2
EARTHWORK                                           .173+05 CU FT
SIDEWATER DEPTH                                     .900+01 FFET
THICKNESS SLAB                                      .101+02 INCHES
WALL THICKNESS                                      .115+02 INCHES
WALL CONCRETE REQUIRED                              .114+04 CU FT
SLAB CONCRETE REQUIRED                              .152+04 CU FT
DRY SOLIDS PRODUCED                                 .618+01 TON/DAY
MAINTENANCE MANPOWER                                .347+03 MAN-HOURS/YR
OPERATION MANPOWER                                  .462+03 MAN-HOURS/YR
ENERGY REQUIRED                                     .779+04 KWHR/YR


                        LIQUID CHARACTERISTICS
FLOW        (MGD)      SOLIDS     (MG/L)               (MG/L)          (MG/L)
MAXIMUM   10.4000      SUSPENDED      2.00    BOD5      10.00     TKN 41.14
AVERAGE   10.4000      VOLATILE      70.00 %  BOD5S     10.00     NH3 41.14
MINIMUM   10.4000      SETTLEABLE      .00    COD       15.00     NO2    .00
                                              CODS      15.00     NO3    .00
TEMP (W)   10.0 C      OIL & GREASE     .00   PO4        5.98
TEMP (S)   23.0 C      CATIONS       160.00
PH          10.5       ANIONS        160.00

                          SLUDGE CHARACTERISTICS
                          PRIMARY           SECONDARY
  VOLUME (GAL/D)         77851.43           25425.23
     % SOLIDS                5.00               5.00
     % VOLATILE             70.00              70.00


   FORMING A THIRD SLUDGE LINE                       PRESENT    1  TRAIN NO    1

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AEROBIC DIGESTION

  RAW SLUDGE SPECIFIC GRAVITY            .105+01
D DETENTION TIME                         .180+02 DAYS
D VOLATILE SOLIDS DESTROYED              .400+02 PERCENT
D MIXED LIQUOR SOLIDS                    .120+05 MG/L
D SOLIDS IN DIGESTED SLUDGE              .250+01 PERCENT
D ALPHA                                  .900+00
D BETA                                   .900+00
D STANDARD TRANSFER EFFICIENCY           .600+01 PERCENT
  DIGESTER VOLUME                        .459+06 GAL
  VOLATILE SOLIDS LOADING                .127+00 LB VS/CUFT/DAY
  SOLIDS ACCUMULATED PER DAY             .601+04 LB/DAY
  DIGESTER CAPACITY                      .458+05 LB
  VOLUME OF WASTED SLUDGE                .209+06 GAL
  SOLIDS RETENTION TIME                  .762+01 DAYS
  OXYGEN REQUIREMENT                     .623+04 LB/DAY
  AIR SUPPLY                             .114+03 CFM/TCFT

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   FORMING A THIRD SLUDGE LINE                     PRESENT    1  TRAIN NO    1

QUANTITIES FOR DIFFUSED AERATION SYSTEM

COMPLETELY MIXED FLOW
AVERAGE DAILY WASTEWATER FLOW                          .254-01 MGD
TOTAL NUMBER OF TANKS                                        2
NUMBER OF BATTERIES                                          1
ACTUAL VOLUME PER TANK                                 .306+05 CU FT
PROCESS AIR REQUIREMENT                                .697+04 SCFM
NUMBER OF DIFFUSERS PER TANK                               291
NUMBER OF SWING ARM HEADERS PER TANK                         3
LENGTH OF AERATION TANKS                               .680+02 FEET
PIPE GALLERY WIDTH                                     .200+02 FEET
VOLUME OF EARTHWORK REQUIRED                           .441+05 CU FT
REINFORCED SLAB CONCRETE REQUIRED                      .100+05 CU FT
REINFORCED WALL CONCRETE REQUIRED                      .882+04 CU FT
HANDRAIL LENGTH                                        .532+03 FEET
OPERATION MANPOWER REQUIRED                            .229+04 MAN-HRS/YEAR
MAINTENANCE MANPOWER REQUIRED                          .126+04 MAN-HRS/YEAR
ELECTRICAL ENERGY REQUIRED                             .361+06 KWHR/YEAR
O & M MATERIAL AND SUPPLY COST                         .250+01 PERCENT


                          LIQUID CHARACTERISTICS
FLOW       (MGD)      SOLIDS     (MG/L)                (MG/L)        (MG/L)
MAXIMUM  10.4000      SUSPENDED    2.00     BOD5      10.00      TKN 41.14
AVERAGE  10.4000      VOLATILE    70.00 %   BOD5S     10.00      NH3 41.14
MINIMUM  10.4000      SETTLEABLE    .00     COD       15.00      NO2   .00
                                            CODS      15.00      NO3   .00
TEMP (W)  10.0 C      OIL & GREASE    .00   PO4        5.98
TEMP (S)  23.0 C      CATIONS      160.00
PH          10.5      ANIONS       160.00


                             SLUDGE CHARACTERISTICS
                             PRIMARY          SECONDARY
   VOLUME (GAL/D)           77851.43          27459.25
      % SOLIDS                  5.00              2.50
      % VOLATILE               70.00             58.33
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   FORMING A THIRD SLUDGE LINE                     PRESENT    1  TRAIN NO    1

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SLUDGE DRYING BEDS

  TOTAL SURFACE AREA REQUIRED     .559+05 SQ FT
D INITIAL DEPTH OF SLUDGE         .120+02 INCHES
D FINAL PERCENT SOLIDS            .500+02
  BED HOLDING TIME                .152+02 DAYS

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   FORMING A THIRD SLUDGE LINE                           PRESENT   1  TRAIN NO   1

QUANTITIES FOR DRYING BED

TOTAL DRYING BED SURFACE AREA                         .559+05 SQ FT
NUMBER BEDS                                                19
SURFACE AREA OF EACH INDIVIDUAL BED                   .294+04 SQ FT
LENGTH OF EACH BED                                    .147+03 FEET
VOLUME OF EARTHWORK REQUIRED                          .275+06 CU FT
VOLUME CONCRETE FOR DIVIDING WALL                     .187+05 CU FT
VOLUME OF R.C. IN-PLACE FOR TRUCK TRACKS              .839+04 CU FT
VOLUME OF SAND                                        .419+05 CU FT
VOLUME OF GRAVEL                                      .559+05 CU FT
CLAY PIPE DIAMETER                                    .600+01 INCHES
TOTAL LENGTH CLAY PIPE                                .559+04 FEET
SLUDGE SOLIDS PER DAY                                 .286+01 TONS/DAY
OPERATION MANPOWER REQUIRED                           .305+04 MAN-HOURS/YR
MAINTENANCE MANPOWER REQUIRED                         .153+04 MAN-HOURS/YR


                              LIQUID CHARACTERISTICS
FLOW         (MGD)      SOLIDS      (MG/L)               (MG/L)          (MG/L)
MAXIMUM    10.4000      SUSPENDED     2.00     BOD5       10.00      TKN 41.14
AVERAGE    10.4000      VOLATILE     70.00 %   BOD5S      10.00      NH3 41.14
MINIMUM    10.4000      SETTLEABLE     .00     COD        15.00      NO2   .00
                                               CODS       15.00      NO3   .00
TEMP (W)   10.0 C       OIL & GREASE     .00   PO4         5.98
TEMP (S)   23.0 C       CATIONS       160.00
PH           10.5       ANIONS        160.00


                                SLUDGE CHARACTERISTICS
                                PRIMARY           SECONDARY
   VOLUME (GAL/D)              77851.43            1372.96
     % SOLIDS                      5.00              50.00
     % VOLATILE                   70.00              58.33
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   FORMING A THIRD SLUDGE LINE                           PRESENT   1  TRAIN NO   1

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SLUDGE HAULING AND LAND FILLING

  VOLUME OF SLUDGE HAULED                  .680+01 CUYD/DAY
  TRUCK CAPACITY                           .190+02 CU YD
D ROUND TRIP TIME TO DISPOSAL SITE         .100+01 HRS
D TRUCK LOADING TIME                       .750+00 HRS
D HOURS OF OPERATION PER DAY               .800+01 HRS
  NUMBER OF TRUCKS REQUIRED                      1
  TONS OF SLUDGE HAULED PER DAY            .601+01 TONS/DAY
D DISTANCE TO DISPOSAL SITE                .100+02 MILES

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   FORMING A THIRD SLUDGE LINE                        PRESENT   1  TRAIN NO   1

QUANTITIES FOR SLUDGE HAULING AND LANDFILL

TOTAL SLUDGE VOLUME HAULED                          .680+01 CUYD/DAY
MAXIMUM ANTICIPATED LANDFILL DOWNTIME               .300+02 DAYS
ANTICIPATED SLUDGE STORAGE HEIGHT                   .800+01 FEET
SLUDGE STORAGE SHED AREA                            .688+03 SQ FT
WIDTH OF SLUDGE STORAGE SHED SLAB                   .186+02 FEET
LENGTH OF SLUDGE STORAGE SHED SLAB                  .371+02 FEET
VOLUME OF EARTHWORK                                 .209+04 CU FT
VOLUME OF SLAB CONCRETE                             .943+03 CU FT
SURFACE AREA OF CANOPY ROOF                         .688+03 SQ FT
DISTANCE TO DISPOSAL SITE                           .100+02 MILES
ROUND TRIP HAUL DISTANCE                            .200+02 MILES
TONS OF SLUDGE HAULED PER DAY                       .601+01 TONS/DAY
OPERATION MANPOWER REQUIRED                         .106+03 MAN-HOURS/YR
ROUND TRIPS PER DAY PER TRUCK                       .100+01
DISTANCE TRAVELED PER YEAR PER TRUCK                .500+04 MILES/YR
MAINTENANCE AND MATERIAL SUPPLY COST                .650+01 PERCENT


                         LIQUID CHARACTERISTICS
FLOW       (MGD)       SOLIDS    (MG/L)              (MG/L)          (MG/L)
MAXIMUM  10.4000       SUSPENDED    2.00     BOD5     10.00      TKN 41.14
AVERAGE  10.4000       VOLATILE    70.00 %   BOD5S    10.00      NH3 41.14
MINIMUM  10.4000       SETTLEABLE    .00     COD      15.00      NO2    .00
                                             COD5     15.00      NO3    .00
TEMP (W)   10.0 C      OIL & GREASE    .00   PO4       5.98
TEMP (S)   23.0 C      CATIONS      160.00
PH           10.5      ANIONS       160.00

                            SLUDGE CHARACTERISTICS
                            PRIMARY          SECONDARY
   VOLUME (GAL/D)          77851.43               .00
     % SOLIDS                  5.00               .00
     % VOLATILE               70.00               .00
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   FORMING A THIRD SLUDGE LINE                        PRESENT   1  TRAIN NO   1

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VACUUM FILTRATION

D LOADING RATE                             .350+01 LB/SQFT/HR
  TOTAL FILTER AREA                        .179+04 SQ FT
  CHEMICAL REQUIREMENTS                    .597+03 LBS/HR
D CHEMICAL DOSE                            .100+02 PERCENT
D LIME
  INITIAL MOISTURE CONTENT                 .950+02 PERCENT
D HOURS OPERATION PER DAY                  .800+01 HOURS
D DAYS OPERATION PER WEEK                  .500+01 DAYS
  AREA PER FILTER                          .595+03 SQ FT
  NUMBER OF UNITS                          .300+01 UNITS

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  FORMING A THIRD SLUDGE LINE                          PRESENT   1  TRAIN NO   1

QUANTITIES FOR VACUUM FILTRATION

ACTUAL TOTAL FILTER AREA                            .179+04 SQ FT
NUMBER OF FILTERS                                         3
CALCULATED AREA FOR SINGLE FILTER                   .595+03 SQ FT
AREA OF THE COMMERCIAL UNIT SELECTED                .675+03 SQ FT
AREA OF BUILDING                                    .300+04 SQ FT
VOLUME OF SLUDGE                                    .779+05 GPD
INITIAL MOISTURE CONTENT OF SLUDGE                  .950+02 PERCENT
DRY SOLIDS PRODUCED                                 .000    TONS/DAY
OPERATION MANPOWER                                  .995+04 MAN-HOURS/YR
MAINTENANCE MANPOWER                                .140+04 MAN-HOURS/YR
ENERGY REQUIRED                                     .412+06 KWHR/YR


                         LIQUID CHARACTERISTICS
FLOW       (MGD)      SOLIDS    (MG/L)               (MG/L)         (MG/L)
MAXIMUM  10.4000      SUSPENDED     2.00     BOD5     10.00      TKN 41.14
AVERAGE  10.4000      VOLATILE     70.00 %   BOD5S    10.00      NH3 41.14
MINIMUM  10.4000      SETTLEABLE     .00     COD      15.00      NO2    .00
                                             CODS     15.00      NO3    .00
TEMP (W)   10.0 C     OIL & GREASE    .00    PO4       5.98
TEMP (S)   23.0 C     CATIONS      160.00
PH           10.5     ANIONS       160.00

                              SLUDGE CHARACTERISTICS
                              PRIMARY         SECONDARY
   VOLUME (GAL/D)               2.79              .00
     % SOLIDS                  31.00              .00
     % VOLATILE               152.61              .00
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  FORMING A THIRD SLUDGE LINE                          PRESENT   1  TRAIN NO   1

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SLUDGE HAULING AND LAND FILLING

  VOLUME OF SLUDGE HAULED                   .138-01 CUYD/DAY
  TRUCK CAPACITY                            .190+02 CU YD
D ROUND TRIP TIME TO DISPOSAL SITE          .100+01 HRS
D TRUCK LOADING TIME                        .750+00 HRS
D HOURS OF OPERATION PER DAY                .800+01 HRS
  NUMBER OF TRUCKS REQUIRED                       1
  TONS OF SLUDGE HAULED PER DAY             .122-01 TONS/DAY
D DISTANCE TO DISPOSAL SITE                 .100+02 MILES

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    FORMING A THIRD SLUDGE LINE                    PRESENT    1  TRAIN NO    1

  QUANTITIES FOR SLUDGE HAULING AND LANDFILL

  TOTAL SLUDGE VOLUME HAULED                          .138-01 CUYD/DAY
  MAXIMUM ANTICIPATED LANDFILL DOWNTIME               .300+02 DAYS
  ANTICIPATED SLUDGE STORAGE HEIGHT                   .800+01 FEET
  SLUDGE STORAGE SHED AREA                            .140+01 SQ FT
  WIDTH OF SLUDGE STORAGE SHED SLAB                   .837+00 FEET
  LENGTH OF SLUDGE STORAGE SHED SLAB                  .167+01 FEET
  VOLUME OF EARTHWORK                                 .398+02 CU FT
  VOLUME OF SLAB CONCRETE                             .129+02 CU FT
  SURFACE AREA OF CANOPY ROOF                         .140+01 SQ FT
  DISTANCE TO DISPOSAL SITE                           .100+02 MILES
  ROUND TRIP HAUL DISTANCE                            .200+02 MILES
  TONS OF SLUDGE HAULED PER DAY                       .122-01 TONS/DAY
  OPERATION MANPOWER REQUIRED                         .216+00 MAN-HOURS/YR
  ROUND TRIPS PER DAY PER TRUCK                       .000
  DISTANCE TRAVELED PER YEAR PER TRUCK                .000    MILES/YR
  MAINTENANCE AND MATERIAL SUPPLY COST                .000    PERCENT


                           LIQUID CHARACTERISTICS
  FLOW        (MGD)      SOLIDS     (MG/L)              (MG/L)        (MG/L)
  MAXIMUM   10.4000      SUSPENDED     2.00     BOD5     10.00     TKN 41.14
  AVERAGE   10.4000      VOLATILE     70.00 %   BOD5S    10.00     NH3 41.14
  MINIMUM   10.4000      SETTLEABLE     .00     COD      15.00     NO2   .00
                                                CODS     15.00     NO3   .00
  TEMP (W)   10.0 C      OIL & GREASE     .00   PO4       5.98
  TEMP (S)   23.0 C      CATIONS       160.00
  PH          10.5       ANIONS        160.00

                             SLUDGE CHARACTERISTICS
                             PRIMARY          SECONDARY
     VOLUME (GAL/D)            .00               .00
       % SOLIDS                .00               .00
       % VOLATILE              .00               .00
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   FORMING A THIRD SLUDGE LINE                     PRESENT    1  TRAIN NO    1

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 SLUDGE TANK 1 CONTENTS REPLACES PRIMARY SLUDGE LINE CONTENTS

 PRIMARY SLUDGE LINE NOW CONTAINS:

                          SLUDGE CHARACTERISTICS
                          VOLUME (GAL/D)    54271.42
                            % SOLIDS            4.00
                            % VOLATILE         60.00

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  FORMING A THIRD SLUDGE LINE                    PRESENT   1  TRAIN NO   1

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ANAEROBIC DIGESTION

D PERCENT V. S. DESTROYED                     .500+02 PERCENT
D SOLIDS CONCENTRATION IN DIGESTER            .500+01 PERCENT
D RAW SLUDGE TEMPERATURE                      .700+02 DEG F
D DIGESTER TEMPERATURE                        .100+03 DEG F
D AIR TEMPERATURE                             .400+02 DEG F
  DETENTION TIME                              .965+01 DAYS
  TOTAL VOLUME                                .742+05 CU FT
  GAS PRODUCED                                .356+04 CUFT/HOUR
  HEAT REQUIREMENT                            .902+06 BTU/HR
  DIGESTER GAS REQUIREMENT                    .209+04 CUFT/HOUR
  TOTAL NATURAL GAS REQUIRED                  .000    CUFT/YEAR
  DIGESTER DEPTH                              .227+02 FEET
  DIGESTER DIAMETER                           .400+02 FEET

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  FORMING A THIRD SLUDGE LINE                    PRESENT   1  TRAIN NO   1

QUANTITIES FOR ANAEROBIC DIGESTION

DIAMETER OF TANK                                   .400+02 FEET
NUMBER OF DIGESTERS PER BATTERY                          3
NUMBER OF BATTERIES                                      1
VOLUME OF EARTHWORK                                .913+05 CU FT
SIDEWATER DEPTH OF DIGESTER                        .227+02 FEET
WALL THICKNESS                                     .188+02 INCHES
REINFORCED WALL CONCRETE                           .169+05 CU FT
SLAB THICKNESS                                     .972+01 INCHES
REINFORCED SLAB CONCRETE                           .353+04 CU FT
SURFACE AREA/FLOOR OF 2-STORY CONTROL BLDG         .626+03 SQ FT
PIPING SIZE                                        .600+01 INCHES
LENGTH OF TOTAL PIPING SYSTEM                      .676+03 FEET
NUMBER OF 90 DEGREE ELBOWS                              39
NUMBER OF TEES                                          77
NUMBER OF PLUG VALVES                                   56
TOTAL DRY SOLIDS TREATED PER DAY                   .951+01 TONS/DAY
ELECTRICAL ENERGY REQUIRED                         .186+06 KWHR/YR
OPERATION MAN-HOUR REQUIREMENT                     .196+04 MAN-HOURS/YR
MAINTENANCE MAN-HOUR REQUIREMENT                   .129+04 MAN-HOURS/YR


                         LIQUID CHARACTERISTICS
FLOW        (MGD)      SOLIDS     (MG/L)              (MG/L)          (MG/L)
MAXIMUM   10.4000      SUSPENDED    2.00    BOD5      10.00      TKN 41.14
AVERAGE   10.4000      VOLATILE    70.00 %  BOD5S     10.00      NH3 41.14
MINIMUM   10.4000      SETTLEABLE    .00    COD       15.00      NO2    .00
                                            CODS      15.00      NO3    .00
TEMP (W)   10.0 C      OIL & GREASE   .00   PO4        5.98
TEMP (S)   23.0 C      CATIONS     160.00
PH           10.5      ANIONS      160.00


                           SLUDGE CHARACTERISTICS
                           PRIMARY          SECONDARY
   VOLUME (GAL/D)        30392.00                .00
     % SOLIDS                5.00                .00
     % VOLATILE             42.86                .00
  FORMING A THIRD SLUDGE LINE                    PRESENT   1  TRAIN NO   1

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SLUDGE DRYING BEDS

  TOTAL SURFACE AREA REQUIRED     .116+06 SQ FT
D INITIAL DEPTH OF SLUDGE         .120+02 INCHES
D FINAL PERCENT SOLIDS            .500+02
  BED HOLDING TIME                .285+02 DAYS

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  FORMING A THIRD SLUDGE LINE                    PRESENT   1  TRAIN NO   1

QUANTITIES FOR DRYING BED

TOTAL DRYING BED SURFACE AREA                        .116+06 SQ FT
NUMBER BEDS                                               39
SURFACE AREA OF EACH INDIVIDUAL BED                  .297+04 SQ FT
LENGTH OF EACH BED                                   .148+03 FEET
VOLUME OF EARTHWORK REQUIRED                         .569+06 CU FT
VOLUME CONCRETE FOR DIVIDING WALL                    .379+05 CU FT
VOLUME OF R.C. IN-PLACE FOR TRUCK TRACKS             .174+05 CU FT
VOLUME OF SAND                                       .868+05 CU FT
VOLUME OF GRAVEL                                     .116+06 CU FT
CLAY PIPE DIAMETER                                   .600+01 INCHES
TOTAL LENGTH CLAY PIPE                               .116+05 FEET
SLUDGE SOLIDS PER DAY                                .634+01 TONS/DAY
OPERATION MANPOWER REQUIRED                          .676+04 MAN-HOURS/YR
MAINTENANCE MANPOWER REQUIRED                        .338+04 MAN-HOURS/YR


                         LIQUID CHARACTERISTICS
FLOW       (MGD)       SOLIDS     (MG/L)                (MG/L)        (MG/L)
MAXIMUM  10.4000       SUSPENDED      2.00    BOD5       10.00      TKN 41.14
AVERAGE  10.4000       VOLATILE      70.00 %  BOD5S      10.00      NH3 41.14
MINIMUM  10.4000       SETTLEABLE      .00    COD        15.00      NO2    .00
                                              CODS       15.00      NO3    .00
TEMP (W)   10.0 C      OIL & GREASE    .00    PO4         5.98
TEMP (S)   23.0 C      CATIONS      160.00
PH           10.5      ANIONS       160.00


                          SLUDGE CHARACTERISTICS
                          PRIMARY          SECONDARY
   VOLUME (GAL/D)         3039.20              .00
     % SOLIDS               50.00              .00
     % VOLATILE             42.86              .00
     FORMING A THIRD SLUDGE LINE                    PRESENT   1  TRAIN NO   1

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 SLUDSE HAULING AND LAND FILLING

    VOLUME OF SLUDGE HAULED              .150+02 CUYD/DAY
    TRUCK CAPACITY                       .190+02 CU YD
 D  ROUND TRIP TIME TO DISPOSAL SITE     .100+01 HRS
 D  TRUCK LOADING TIME                   .750+00 HRS
 D  HOURS OF OPERATION PER DAY           .800+01 HRS
    NUMBER OF TRUCKS REQUIRED                  1
    TONS OF SLUDGE HAULED PER DAY        .133+02 TONS/DAY
 D  DISTANCE TO DISPOSAL SITE            .100+02 MILES

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     FORMING A THIRD SLUDGE LINE                    PRESENT   1  TRAIN NO   1

 QUANTITIES FOR SLUDGE HAULING AND LANDFILL

 TOTAL SLUDGE VOLUME HAULED                      .150+02 CUYD/DAY
 MAXIMUM ANTICIPATED LANDFILL DOWNTIME           .300+02 DAYS
 ANTICIPATED SLUDGE STORAGE HEIGHT               .800+01 FEET
 SLUDGE STORAGE SHED AREA                        .152+04 SQ FT
 WIDTH OF SLUDGE STORAGE SHED SLAB               .276+02 FEET
 LENGTH OF SLUDGE STORAGE SHED SLAB              .552+02 FEET
 VOLUME OF EARTHWORK                             .435+04 CU FT
 VOLUME OF SLAB CONCRETE                         .190+04 CU FT
 SURFACE AREA OF CANOPY ROOF                     .152+04 SQ FT
 DISTANCE TO DISPOSAL SITE                       .100+02 MILES
 ROUND TRIP HAUL DISTANCE                        .200+02 MILES
 TONS OF SLUDGE HAULED PER DAY                   .133+02 TONS/DAY
 OPERATION MANPOWER REQUIRED                     .235+03 MAN-HOURS/YR
 ROUND TRIPS PER DAY PER TRUCK                   .100+01
 DISTANCE TRAVELED PER YEAR PER TRUCK            .500+04 MILES/YR
 MAINTENANCE AND MATERIAL SUPPLY COST            .650+01 PERCENT


                          LIQUID CHARACTERISTICS
 FLOW        (MGD)     SOLIDS     (MG/L)              (MG/L)        (MG/L)
 MAXIMUM   10.4000     SUSPENDED      2.00   BOD5      10.00      TKN 41.14
 AVERAGE   10.4000     VOLATILE      70.00 %  BOD5S    10.00      NH3 41.14
 MINIMUM   10.4000     SETTLEABLE      .00   COD       15.00      NO2   .00
                                             CODS      15.00      NO3   .00
 TEMP (W)   10.0 C     OIL & GREASE     .00  PO4        5.98
 TEMP (S)   23.0 C     CATIONS       160.00
 PH           10.5     ANIONS        160.00

                              SLUDGE CHARACTERISTICS
                              PRIMARY         SECONDARY
    VOLUME (GAL/D)              .00              .00
      % SOLIDS                  .00              .00
      % VOLATILE                .00              .00
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   FORMING A THIRD SLUDGE LINE                       PRESENT   1  TRAIN NO   1

QUANTITIES FOR LIME FEED SYSTEM

LIME FEED RATE OF CA(OH)2                          .265+05 LBS/DAY
EPA COST INDEX USED                                .140+03
LIQUID CHEMICAL SOLUTION FED PER DAY               .529+05 GAL/DAY
OPERATION AND MAINTENANCE MANPOWER                 .139+05 MAN-HOURS/YR
DRY MATERIAL HANDLING AND MIXING MANPOWER          .200+04 MAN-HOURS/YR
TOTAL OPERATION AND MAINTENANCE MANPOWER           .159+05 MAN-HOURS/YR
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   FORMING A THIRD SLUDGE LINE                       PRESENT   1  TRAIN NO   1

QUANTITIES FOR BLOWERS

DESIGN CAPACITY FOR BLOWER SYSTEM                  .328+05 SCFM
NUMBER OF BLOWERS FOR MAX AIR REQUIREMENTS               2
CAPACITY OF INDIVIDUAL BLOWERS                     .164+05 SCFM
TOTAL NUMBER OF BLOWERS REQUIRED                         3
BLOWER BUILDING AREA                               .183+04 SQ FT
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    FORMING A THIRD SLUDGE LINE              PRESENT   1  TRAIN NO   1

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LIQUID    PREL  0  PRIM  0  P ST  0  COMP  0  COAG  0  CHLO  0
SECONDARY GRAV  0  AERO  0  DRYI  0  HAUL  0
PRIMARY   VACU  0  HAUL  0  P RE  0  ANAE  0  DRYI  0  HAUL  0

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                                 COST SUMMARY

                                   OPER     MAINT                                         TOTAL
             CAPITAL    AMMORT     LABOR    LABOR       POWER    MATERIAL    CHEMICAL     O & M
   UNIT       COST        COST      COST     COST        COST       COST        COST.      COST
                $         $/YR      $/YR     $/YR        $/YR       $/YR        $/YR       $/YR
PRELIMIN*    159346      11909     13915     6357        1859       3983           0      26114
PRIM CLA     532190      39776      7623     3842         406       5321           0      17192
COMP MIX    1684980     126735     32289    18570      249831      32706           0     333396
A SEC CL     789852      59934     11570     5863         499       7898           0      25830
RCY PUMP     166633      13826      4693     3633       27715       1166           0      37207
COAG F/C    1350705     100954     30752    10488        3547      13507      423999     482293
CHLORINA     181230      14448     10741     2511        5292       5615       18495      42654
GRAV THC     127357       9518      3359     2312         311       1273           0       7255
AERO DIG     261533      19686     16683     8417       14627       6338           0      46065
DRY BEDS     259095      19737     22208    10153           0       2331           0      34692
HAUL SLF      66010      11167       773        0           0      11054           0      11827
VACU FIL    1435295     119553     72411     9296       16485      65464       66470     230124
HAUL SLF      47133       9756         1        0           0       8000           0       8001
ANAE DIG     971306      74277     14226     8593        7437       8020           0      38276
DRY BEDS     529153      40320     49160    22474           0       4762           0      76396
HAUL SLF      87488      12772      1712        0           0      11054           0      12766
LIME F/S     318091      23774    115568        0           0       6361           0     121929
BLOWERS      480629      35908         0        0           0          0           0          0

SUB TOTAL   9447832     743161    407691   112514      327815     195062      490469    1552017

* WARNING - COST ESTIMATES ARE FROM PARAMETRIC EQUATIONS

DIRECT COSTS
 PROFIT/OVERHEAD                  2078523 $

   SUB TOTAL (OTHER DIRECT)       2078523 $          TOTAL CONSTRUCTION COST  11526355 $

INDIRECT COSTS
 MISC NON CONST COSTS              576317 $
 ADMIN/LEGAL                       230527 $
 201 PLANNING                      403422 $
 A/E DESIGN FEE                    673977 $
 INSPECTION                        230527 $
 CONTINGENCIES                     922108 $
 TECHNICAL COSTS                   230527 $


   SUB TOTAL (INDIRECT)           3267405 $

LAND COSTS                          20000 $    (   20. ACRES)
INTEREST DURING CONSTRUCTION      1472117 $

ADMINISTRATIVE COST                 28414 $/YR
LABORATORY COST                     28649 $/YR

TOTAL PROJECT COST  16285877 $     TOTAL CONSTRUCTION COST  11526355 $
FINAL YEAR O & M     1590618 $/YR  TOTAL STEP III COST      15208478 $
INITIAL YEAR O & M   1181476 $/YR  PRESENT WORTH (APP. A)   34804754 $
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    FORMING A THIRD SLUDGE LINE                    PRESENT   1  TRAIN NO   1

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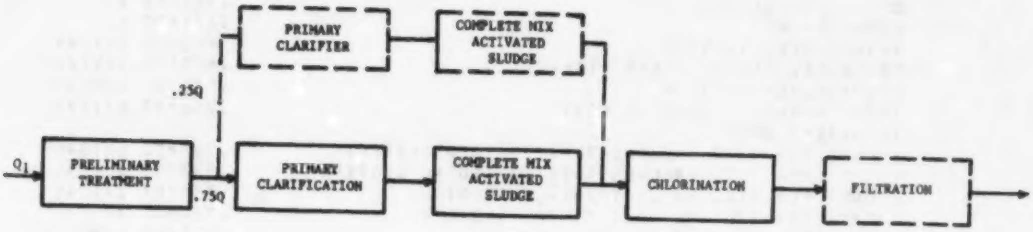
 USER CHARGE SUMMARY

 D EPA GRANT                                                .750+02 PERCENT
 D STATE GRANT                                              .000    PERCENT
 D ALLOWANCE FOR FINANCING                                  .300+01 PERCENT
   BONDS                 PERCENT  RATE  LIFE
 D   REVENUE             100.00 10.00    30
 D   GENERAL OBLIGATION     .00    .00   30
 D   OTHER                  .00    .00   30
 D EXISTING SEWER RATE                                      .000    $/TGAL
 D PERSONS PER HOUSEHOLD                                    .350+01
 D GALLONS/CAPITA/DAY (WATER USE)                           .100+03 GPCPD
   TOTAL PROJECT COST                                       .163+08 $
   EPA ELIGIBLE COST                                        .163+08 $
   LOCAL SHARE                                              .421+07 $
   ANNUAL DEBT SERVICE                                      .446+06 $/YEAR
   PRINCIPAL AND INTEREST RESERVE                           .638+05 $/YEAR
   CONTINGENCY RESERVE                                      .638+05 $/YEAR
   TOTAL ANNUAL OPERATING COST                              .216+07 $/YEAR
   TREATMENT COST
     COST PER 1000 GALLONS TREATED (NEW SYSTEM)             .593+00 $/TGAL
     COST PER 1000 GALLONS TREATED (TOTAL SYSTEM)           .593+00 $/TGAL
     COST PER BILLING UNIT (NEW SYSTEM)                     .119+01 $/TGAL
     COST PER BILLING UNIT (TOTAL SYSTEM)                   .119+01 $/TGAL
     COST PER HOUSEHOLD (NEW SYSTEM)                        .125+02 $/MONTH
     COST PER HOUSEHOLD (TOTAL SYSTEM)                      .125+02 $/MONTH
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

@XQT CAPDET.NEWPAGE
```

c. EXAMPLE 3: SPLITTING AND MERGING FLOWS

Description: In many plant upgrading or expansion schemes it may be desirable to bypass an existing treatment process or to use existing treatment processes augmented by parallel units. This may be accomplished be using the SPLIT and MERGE flow control functions and the cost override option found on page 3-32. For simplicity, this example considers only the liquid line. In block diagram format, a typical scheme may be described by the following illustration.

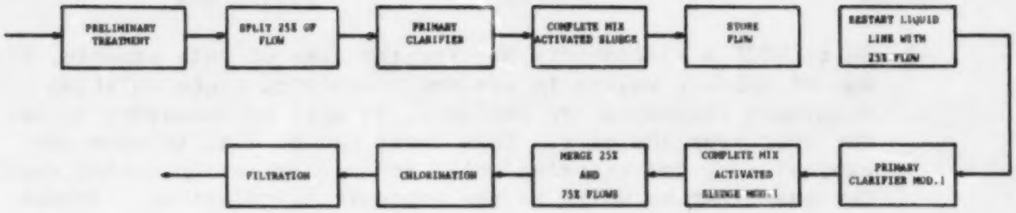


PRIMARY CLARIFIER
COMPLETE MIX ACTIVATED SLUDGE
.25Q
Q_I
PRELIMINARY TREATMENT
.75Q
PRIMARY CLARIFICATION
COMPLETE MIX ACTIVATED SLUDGE
CHLORINATION
FILTRATION

Assume that the preliminary treatment and chlorination processes are sufficient to handle anticipated flows. The primary clarification and complete mix activated sludge process can adequately treat only 75 percent of anticipated flows. The filtration process is to be added as well as parallel primary clarification and complete mix activated sludge units.

(1) Refer to Chapter 5 for a discussion of flow control functions. Refer to Appendix B for a discussion of the basic procedure for using CAPDET. The procedure for using CAPDET is the same as that found in Appendix B with the additions or modifications discussed below.

(2) As discussed in STEP 1 of Appendix B, construct a CAPDET block diagram. The available treatment process (block cards) are augmented by the six flow control functions (Chapter 5).


PRELIMINARY TREATMENT
SPLIT 25% OF FLOW
PRIMARY CLARIFIER
COMPLETE MIX ACTIVATED SLUDGE
STORE FLOW
RESTART LIQUID LINE WITH 25% FLOW
PRIMARY CLARIFIER MOD. 1
COMPLETE MIX ACTIVATED SLUDGE MOD. 1
MERGE 25% AND 75% FLOWS
CHLORINATION
FILTRATION

(3) Go to STEP 2 of Appendix B. For each treatment process or flow control function selected (list of treatment processes on page 2-11; flow control function on page 5-3), identify appropriate key words.

EXAMPLE:

Treatment Process or Flow Control Key Words	Associated Unit Process Key Words	Unit Process Name
PRELIM	GRIT R	Grit removal
	SCREEN	Bar screens
	COMMIN	Comminution
L SP 25 1	None	None
PRIMAR	PRIMAR	Primary clarification
COMPLE	COMPLE	Complete mix aeration
	A SECO	Secondary clarification
L ST 2	None	None
L RE 1	None	None
PRIMAR1	PRIMAR1	Primary clarification modification 1

COMPLE1	COMPLE1	Complete mix action modification 1 Secondary clarification modification 1
L ME 2	None	None
CHLORI	CHLORI	Chlorination
FILTRA	FILTRA	Filtration

(4) Go to STEP 3 of Appendix B. For the sake of this example, the use of default values is assumed. However, since existing treatment processes are included, it will be necessary to use the cost override card. This input can be used to zero the capital cost for existing units and add actual operating costs for the existing units to the economic calculations. (Refer to page 3-32.)

EXAMPLE:

```
COSTS OVERRIDE
PRIMARY CLARIFIER  0   0    100    100     1000     500        0   40
COMPLETE MIX       0   0   1000   1000   100000   20000        0   30
CHLORINATION       0   0    100    100     2500    3000    10000   30
END
```

(5) Perform STEP 4 of Appendix B.

(6) Perform STEP 5 of Appendix B.

EXAMPLE:

```
    LIQUID LINE
    BLOCK      PRELIM
    L SP 25 1
    BLOCK      PRIMAR
    BLOCK      COMPLE
    L ST 2
    L RE 1
    BLOCK      PRIMAR1
    BLOCK      COMPLE1
    L ME 2
    BLOCK      CHLORI
    BLOCK      FILTRA
```

(7) Perform STEPS 6, 7, 8, and 9 of Appendix B.

(8) Assemble all data coded above and submit it to the CAPDET program.

EXAMPLE: The complete data list for example 3 above would be:

```
COSTS OVERRIDE
PRIMARY CLARIFIER  0   0    100    100     1000     500      0  40
COMPLETE MIX       0   0   1000   1000   100000   20000      0  30
CHLORINATION       0   0    100    100     2500    3000  10000  30
END

TITLE            SPLIT AND MERGE EXAMPLE
LIQUID LINE
BLOCK            PRELIM
L SP 25 1
BLOCK            PRIMAR
BLOCK            COMPLE
L ST 2
L RE 1
BLOCK            PRIMAR1
BLOCK            COMPLE1
L ME 2
BLOCK            CHLORI
BLOCK            FILTRA
SECONDARY SLUDGE LINE
BLOCK            A MIX
PRIMARY SLUDGE LINE
BLOCK            AEROBI ANAERO
BLOCK            DRYING
BLOCK            HAULIN
WASTE INFLUENT
AVERAGE FLOW       FINAL = 10.0     INITIAL = 5.0 MGD
BOD5                                              300         MG/L
OIL AND GREASE                      0             MG/L
DESIRED EFFLUENT CHARACTERISTICS
UNIT COSTS
BUILDING                                          42.0        $/SQ FT
EXCAVATION                                        1.75        $/CU YD
WALL CONCRETE                       275.0         $/CU YD
SLAB CONCRETE                       230.0         $/CU YD
MARSHALL AND SWIFT                                545.0
SMALL CITY EPA INDEX                              140.0
END
CONTROL CARDS
LIST                                              4           TRAINS
PRINT TRAIN NO 1
OUTPUT QUANTITIES
GO               I = 6.625          YEARS = 30    CP = 3
```

```
COSTS OVERRIDES
PRIMARY CLARIFIER 0 0 100 100 1000 500 0 40
COMPLETE MIX 0 0 1000 1000 100000 20000 0 30
CHLORINATION 0 0 100 100 2500 3000 10000 30
END
TITLE    SPLIT AND MERGE EXAMPLE
LIQUID LINE
BLOCK     PRELIM
L SP 25 1
BLOCK     PRIMAR
BLOCK     COMPLE
L ST 2
L RE 1
BLOCK     PRIMAR1
BLOCK     COMPLE1
L ME 2
BLOCK     CHLORI
BLOCK     FILTRA
SECONDARY SLUDGE LINE
BLOCK     A MIX
PRIMARY SLUDGE LINE
BLOCK     AEROBI ANAERO
BLOCK     DRYING
BLOCK     HAULIN
WASTE INFLUENT
AVERAGE FLOW       10.0 MGD    QINIT  5.0 MGD
BOD5              300.0 MG/L
OIL AND GREASE      0.0 MG/L
DESIRED EFFLUENT CHARACTERISTICS
UNIT COSTS
BUILDING            42.00  $/SQFT
EXCAVATION           1.75  $/CUYD
WALL CONCRETE      275.00  $/CUYD
SLAB CONCRETE      230.00  $/CUYD
MARSHALL AND SWIFT 545.00
SMALL CITY EPA INDEX  140.00
END
CONTROL CARDS
LIST              4 TRAINS
PRINT TRAIN NO  1
OUTPUT QUANTITIES
GO             I=6.625     30 YEARS  CP=3 YEARS
```

```
                     COST ANALYSIS INPUT PARAMETERS
                        INTEREST RATE                      6.625 PERCENT
                        PLANNING PERIOD                       30 YEARS


      UNIT PRICES AND COSTS INDICES

    I BUILDING                                  42.00 $/SQFT
    I EXCAVATION                                 1.75 $/CUYD
    I WALL CONCRETE                            275.00 $/CUYD
    I SLAB CONCRETE                            230.00 $/CUYD
    I MARSHALL AND SWIFT INDEX                 545.00
    D CRANE RENTAL                              67.00 $/HR
    I EPA CONSTRUCTION COST INDEX              140.00
    D CANOPY ROOF                               15.75 $/SQFT
    D LABOR RATE                                13.40 $/HR
    D OPERATOR CLASS II                          7.50 $/HR
    D ELECTRICITY                                 .04 $/KWHR
    D CHEMICAL COSTS
        LIME                                      .03 $/LB
        ALUM                                      .04 $/LB
        IRON SALTS                                .06 $/LB
        POLYMER                                  1.62 $/LB
    D ENGINEERING NEWS RECORD COST INDEX      2886.00
    D HANDRAIL                                  25.20 $/FT
    D PIPE COST INDEX                          295.20
    D PIPE INSTALLATION LABOR RATE              14.70 $/HR
    D EIGHT INCH PIPE                            9.08 $/FT
    D EIGHT INCH PIPE BEND                      86.82 $/UNIT
    D EIGHT INCH PIPE TEE                      128.49 $/UNIT
    D EIGHT INCH PIPE VALVE                   1346.16 $/UNIT
```

```
   SPLIT AND MERGE EXAMPLE

    PRESENT TRN     PROJECT TRN  CONSTRUCT TRN    O&M    TRN   ENERGY TRN
     WORTH   #       COST    #      COST    #     COST    #     COST   #
   13642801   1     7938214   1    5595382   1   52868[illegible]   2   183101   2
   14841520   2     8148481   2    5744662   2   555596   1   199738   1

TRAIN NO   1
LIQUID     PREL  0  L SP  1  PRIM  0  COMP  0  L ST  2  L RE  1  PRIM  1  COMP  1  L ME  2  CHLO  0
           FILT  0
SECONDARY A MI   0
PRIMARY    AERO  0  DRYI  0  HAUL  0

TRAIN NO   2
LIQUID     PREL  0  L SP  1  PRIM  0  COMP  0  L ST  2  L RE  1  PRIM  1  COMP  1  L ME  2  CHLO  0
           FILT  0
SECONDARY A MI   0
PRIMARY    ANAE  0  DRYI  0  HAUL  0
```

```
   SPLIT AND MERGE EXAMPLE                          PRESENT    1   TRAIN NO    1
                                      INFLUENT


                              LIQUID CHARACTERISTICS
FLOW        (MGD)         SOLIDS     (MG/L)                 (MG/L)         (MG/L)
MAXIMUM   10.0000         SUSPENDED  200.00      BOD5      300.00       TKN 65.00
AVERAGE   10.0000         VOLATILE     60.00 %   BOD5S      75.00       NH3 25.00
MINIMUM   10.0000         SETTLEABLE  15.00      COD       500.00       NO2   .00
                                                 CODS      400.00       NO3   .00
TEMP (W)   10.0 C         OIL & GREASE     .00   PO4        18.00
TEMP (S)   23.0 C         CATIONS        160.00
PH            7.6         ANIONS         160.00

                               SLUDGE CHARACTERISTICS
                               PRIMARY          SECONDARY
  VOLUME (GAL/D)                 .00               .00
    % SOLIDS                     .00               .00
    % VOLATILE                   .00               .00

  SPLIT AND MERGE EXAMPLE                          PRESENT    1   TRAIN NO    1

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

MECHANICALLY CLEANED BAR SCREEN

D BAR SIZE                                          .250+00 INCHES
D BAR SPACING                                       .150+01 INCHES
D SLOPE OF BARS FROM HORIZONTAL                     .300+02 DEG
  HEAD LOSS THROUGH SCREEN                          .206-01 FEET
D APPROACH VELOCITY                                 .250+01 FT/SEC
D AVERAGE FLOW THROUGH VELOCITY                     .250+01 FT/SEC
D MAXIMUM FLOW THROUGH VELOCITY                     .300+01 FT/SEC
  SCREEN CHANNEL WIDTH                              .616+01 FEET
D AVERAGE CHANNEL DEPTH                             .100+01 FEET

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
  SPLIT AND MERGE EXAMPLE                          PRESENT    1   TRAIN NO    1

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

  AERATED GRIT CHAMBER

  MAXIMUM FLOW                            .154+02 CFS
  AVERAGE FLOW                            .154+02 CFS
  MINIMUM FLOW                            .154+02 CFS
  TEMPERATURE                             .100+02 DEG C
D MAXIMUM FLOW THROUGH VELOCITY           .113+00 FPS
D AVERAGE FLOW THROUGH VELOCITY           .113+00 FPS
D SIZE SMALL. PART. 100% REMOVED          .200+00 MM
D SPECIFIC GRAVITY OF PARTICLE            .265+01
D NUMBER OF UNITS                         .200+01
  MAXIMUM FLOW/UNIT                       .770+01 CFS
D WIDTH OF CHANNEL                        .170+02 FEET
D DEPTH OF CHANNEL                        .400+01 FEET
  LENGTH OF CHANNEL                       .170+02 FEET
  SETTLING VELOCITY OF PARTICLE           .105+03 FPS
D DETENTION TIME                          .250+01 MIN
  VOLUME OF GRIT                          .400+02 CUFT/DAY
D AIR SUPPLY                              .300+01 CFM

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

```
   SPLIT AND MERGE EXAMPLE                         PRESENT    1   TRAIN NO    1

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

COMMINUTION

D NUMBER OF UNITS                        .200+01 UNITS
  DRUM DIAMETER                          .250+02 INCHES
  DRUM RPM                               .250+02 REV/MIN
  AVERAGE SLOT WIDTH                     .380+00 INCHES
  HORSEPOWER/UNIT                        .150+01 HP
  STANDARD HEIGHT                        .579+01 FEET
  STANDARD NET WEIGHT                    .210+04 POUNDS

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *


                          LIQUID CHARACTERISTICS
FLOW        (MGD)      SOLIDS      (MG/L)              (MG/L)          (MG/L)
MAXIMUM   10.0000      SUSPENDED   200.00     BOD5     300.00      TKN 45.00
AVERAGE   10.0000      VOLATILE     60.00 %   BOD5S     75.00      NH3 25.00
MINIMUM   10.0000      SETTLEABLE   15.00     COD      500.00      NO2   .00
                                              CODS     400.00      NO3   .00
TEMP (W)   10.0 C      OIL & GREASE     .00   PO4       18.00
TEMP (S)   23.0 C      CATIONS       160.00
PH            7.6      ANIONS        160.00

                             SLUDGE CHARACTERISTICS
                             PRIMARY          SECONDARY
   VOLUME (GAL/D)               .00                .00
     % SOLIDS                   .00                .00
     % VOLATILE                 .00                .00


   SPLIT AND MERGE EXAMPLE                         PRESENT    1   TRAIN NO    1

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

 25.0 PERCENT OF LIQUID LINE STORED IN TANK 1

   7.500 MGD REMAINS IN THE LIQUID LINE

TANK 1 NOW CONTAINS:


                          LIQUID CHARACTERISTICS
FLOW        (MGD)      SOLIDS      (MG/L)              (MG/L)          (MG/L)
MAXIMUM     2.5000     SUSPENDED   200.00     BOD5     300.00      TKN 45.00
AVERAGE     2.5000     VOLATILE     60.00 %   BOD5S     75.00      NH3 25.00
MINIMUM     2.5000     SETTLEABLE   15.00     COD      500.00      NO2   .00
                                              CODS     400.00      NO3   .00
TEMP (W)   10.0 C      OIL & GREASE     .00   PO4       18.00
TEMP (S)   23.0 C      CATIONS       160.00
PH            7.6      ANIONS        160.00

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

```
   SPLIT AND MERGE EXAMPLE                    PRESENT    1  TRAIN NO    1

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

PRIMARY CLARIFIER

 CIRCULAR CLARIFIER

D SURFACE OVERFLOW RATE              .100+04 GAL/DAY/SQFT
  SURFACE AREA                       .750+04 SQ FT
D SIDE WATER DEPTH                   .900+01 FEET
  DETENTION TIME                     .162+01 HOURS
  SOLID LOADING                      .167+01 LB/SQFT/DAY
D WEIR LOADING                       .150+05 GAL/DAY/FT
  WEIR LENGTH                        .500+03 FEET
  VOLUME OF SLUDGE PRODUCED          .207+05 GAL/DAY
D SUSPENDED SOLIDS REMOVAL           .580+02 PERCENT
D BOD REMOVAL                        .320+02 PERCENT
D COD REMOVAL                        .400+02 PERCENT
D TKN REMOVAL                        .500+01 PERCENT
D PO4 REMOVAL                        .500+01 PERCENT

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

QUANTITIES FOR SEDIMENTATION

CIRCULAR CLARIFIER

PRIMARY CLARIFIER
EXCESS CAPACITY FACTOR                       .100+01
CALCULATED SURFACE AREA                      .750+04 SQ FT
ADJUSTED SURFACE AREA                        .750+04 SQ FT
AVERAGE DAILY WASTEWATER FLOW                .750+01 MGD
NUMBER OF CIRCULAR CLARIFIERS                      2
NUMBER OF BATTERIES                                1
SURFACE AREA PER UNIT                        .375+04 SQ FT
DIAMETER OF UNIT                             .700+02 FEET
EARTHWORK REQUIRED                           .958+05 CU FT
SIDEWATER DEPTH                              .900+01 FEET
THICKNESS OF THE SLAB                        .101+02 INCHES
WALL THICKNESS                               .115+02 INCHES
TOTAL  WALL CONCRETE REQUIRED                .464+04 CU FT
TOTAL SLAB CONCRETE REQUIRED                 .764+04 CU FT
MAINTENANCE MANPOWER REQUIRED                .473+03 MAN-HOURS/YR
OPERATION MANPOWER REQUIRED                  .861+03 MAN-HOURS/YR
ELECTRICAL ENERGY REQUIRED                   .963+04 KWHR/YR


                       LIQUID CHARACTERISTICS
FLOW      (MGD)     SOLIDS    (MG/L)           (MG/L)      (MG/L)
MAXIMUM   7.5000    SUSPENDED  84.00     BOD5   204.00     TKN 42.75
AVERAGE   7.5000    VOLATILE   60.00 %   BOD5S   75.00     NH3 25.00
MINIMUM   7.5000    SETTLEABLE   .00     COD    400.00     NO2   .00
                                         CODS   400.00     NO3   .00
TEMP (W)  10.0 C    OIL & GREASE    .00  PO4     17.10
TEMP (S)  23.0 C    CATIONS      160.00
PH          7.6     ANIONS       160.00

                          SLUDGE CHARACTERISTICS
                          PRIMARY        SECONDARY
   VOLUME (GAL/D)      20714.29               .00
     % SOLIDS              4.00               .00
     % VOLATILE           60.00               .00
   SPLIT AND MERGE EXAMPLE                              PRESENT   1  TRAIN NO   1

 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

 COMPLETE MIX ACTIVATED SLUDGE

 D REACTION RATE CONSTANT                   .135-02 L/MG-H
 D SLUDGE PRODUCED PER BOD REMOVED          .730+00
 D ENDOGENEOUS RATE  (OXYGEN BASIS)         .150+00 /DAY
 D O2 UTILIZED PER BOD REMOVED              .520+00
 D ENDOGENEOUS RATE  (SLUDGE BASIS)         .750-01 /DAY
 D INFLUENT NON-DEGRADABLE VSS              .400+00
 D EFFLUENT DEGRADABLE VSS                  .530+00
 D LB BOD/LB MLSS-DAY                       .500+00
 D MIXED LIQUOR SS                          .450+04 MG/L
 D MIXED LIQUOR VS                          .315+04 MG/L
   AERATION TIME                            .644+01 HOURS
   VOLUME OF AERATION TANK                  .201+01 MG
   OXYGEN REQUIRED                          .160+05 LB/DAY
   SLUDGE PRODUCED                          .766+04 LB/DAY
   NITROGEN REQUIREMENT                     .970+01 MG/L
   PHOSPHOROUS REQUIREMENT                  .194+01 MG/L
   SLUDGE RECYCLE RATIO                     .818+02 PERCENT
   SOLIDS RETENTION TIME                    .986+01 DAYS
   VOLUMETRIC LOADING                       .475+02 LB BOD/TCFT

 DIFFUSED AERATION SYSTEM

 D STANDARD TRANSFER EFFICIENCY             .600+01 PERCENT
   OPERATING EFFICIENCY                     .357+01 PERCENT
   REQUIRED AIR FLOW                        .656+02 CFM/TCFT

 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *



   SPLIT AND MERGE EXAMPLE                              PRESENT   1  TRAIN NO   1

 QUANTITIES FOR DIFFUSED AERATION SYSTEM

 COMPLETELY MIXED FLOW
 AVERAGE DAILY WASTEWATER FLOW                          .750+01 MGD
 TOTAL NUMBER OF TANKS                                        4
 NUMBER OF BATTERIES                                          1
 ACTUAL VOLUME PER TANK                                 .672+05 CU FT
 PROCESS AIR REQUIREMENT                                .176+05 SCFM
 NUMBER OF DIFFUSERS PER TANK                               368
 NUMBER OF SWING ARM HEADERS PER TANK                         6
 LENGTH OF AERATION TANKS                               .149+03 FEET
 PIPE GALLERY WIDTH                                     .230+02 FEET
 VOLUME OF EARTHWORK REQUIRED                           .171+06 CU FT
 REINFORCED SLAB CONCRETE REQUIRED                      .614+05 CU FT
 REINFORCED WALL CONCRETE REQUIRED                      .335+05 CU FT
 HANDRAIL LENGTH                                        .200+04 FFET
 OPERATION MANPOWER REQUIRED                            .366+04 MAN-HRS/YEAR
 MAINTENANCE MANPOWER REQUIRED                          .221+04 MAN-HRS/YEAR
 ELECTRICAL ENERGY REQUIRED                             .426+07 KWHR/YEAR
 O & M MATERIAL AND SUPPLY COST                         .211+01 PERCENT
```

```
  SPLIT AND MERGE EXAMPLE                           PRESENT   1  TRAIN NO    1

 QUANTITIES FOR RECYCLE PUMPING

 AVERAGE DAILY PUMPING RATE                         .750+01 MGD
 TOTAL PUMPING CAPACITY                             .750+01 MGD
 DESIGN CAPACITY PER PUMP                           .260+04 GPM
 NUMBER OF PUMPS                                          3
 NUMBER OF BATTERIES                                      1
 AREA OF PUMP BUILDING                              .348+03 SQ FT
 VOLUME OF EARTHWORK REQUIRED                       .278+04 CU FT
 FIRM PUMPING CAPACITY                              .750+01 MGD
 OPERATING MANPOWER REQUIRED                        .578+03 MAN-HOURS/YR
 MAINTENANCE MANPOWER REQUIRED                      .491+03 MAN-HOURS/YR
 ELECTRICAL ENERGY REQUIRED                         .500+06 KWHR/YR
```

```
  SPLIT AND MERGE EXAMPLE                           PRESENT   1  TRAIN NO    1

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

SECONDARY CLARIFIER FOR ACTIVATED SLUDGE

 CIRCULAR CLARIFIER

  SOLIDS LOADING RATE                   .188+02 LB/SQFT/DAY
  SURFACE AREA                          .150+05 SQ FT
D SURFACE OVERFLOW RATE                 .500+03 GAL/SQFT/DAY
  DETENTION TIME                        .323+01 HOURS
D WEIR OVERFLOW RATE                    .150+05 GAL/FT/DAY
D TANK SIDEWATER DEPTH                  .900+01 FEET
  WEIR LENGTH                           .500+03 FEET
  VOLUME OF WASTED SLUDGE               .891+05 GAL/DAY
D UNDERFLOW CONCENTRATION               .100+01 PERCENT

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

```
     SPLIT AND MERGE EXAMPLE                                   PRESENT   1  TRAIN NO   1

   QUANTITIES FOR SEDIMENTATION

   CIRCULAR CLARIFIER

   SECONDARY CLARIFIER
   EXCESS CAPACITY FACTOR                              .100+01
   CALCULATED SURFACE AREA                             .150+05 SQ FT
   ADJUSTED SURFACE AREA                               .150+05 SQ FT
   AVERAGE DAILY WASTEWATER FLOW                       .750+01 MGD
   NUMBER OF CIRCULAR CLARIFIERS                             2
   NUMBER OF BATTERIES                                       1
   SURFACE AREA PER UNIT                               .750+04 SQ FT
   DIAMETER OF UNIT                                    .980+02 FEET
   EARTHWORK REQUIRED                                  .202+06 CU FT
   SIDEWATER DEPTH                                     .900+01 FEET
   THICKNESS OF THE SLAB                               .101+02 INCHES
   WALL THICKNESS                                      .115+02 INCHES
   TOTAL  WALL CONCRETE REQUIRED                       .641+04 CU FT
   TOTAL SLAB CONCRETE REQUIRED                        .145+05 CU FT
   MAINTENANCE MANPOWER REQUIRED                       .722+03 MAN-HOURS/YR
   OPERATION MANPOWER REQUIRED                         .131+04 MAN-HOURS/YR
   ELECTRICAL ENERGY REQUIRED                          .108+05 KWHR/YR


                            LIQUID CHARACTERISTICS
   FLOW        (MGD)      SOLIDS     (MG/L)             (MG/L)          (MG/L)
   MAXIMUM     7.5000     SUSPENDED    20.00     BOD5     15.34       TKN 29.92
   AVERAGE     7.5000     VOLATILE     70.00 %   BOD5S    10.00       NH3 29.92
   MINIMUM     7.5000     SETTLEABLE     .00     COD      23.01       NO2    .00
                                                 CODS     15.00       NO3    .00
   TEMP (W)    10.0 C     OIL & GREASE     .00   PO4      11.97
   TEMP (S)    23.0 C     CATIONS      160.00
   PH             7.6     ANIONS       160.00


                              SLUDGE CHARACTERISTICS
                              PRIMARY          SECONDARY
      VOLUME (GAL/D)         20714.29          89126.21
        % SOLIDS                 4.00              1.00
        % VOLATILE              60.00             70.00

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   100.0 PERCENT OF LIQUID LINE STORED IN TANK 2

       .000 MGD REMAINS IN THE LIQUID LINE

   TANK 2 NOW CONTAINS:


                            LIQUID CHARACTERISTICS
   FLOW        (MGD)      SOLIDS     (MG/L)             (MG/L)          (MG/L)
   MAXIMUM     7.5000     SUSPENDED    20.00     BOD5     15.34       TKN 29.92
   AVERAGE     7.5000     VOLATILE     70.00 %   BOD5S    10.00       NH3 29.92
   MINIMUM     7.5000     SETTLEABLE     .00     COD      23.01       NO2    .00
                                                 CODS     15.00       NO3    .00
   TEMP (W)    10.0 C     OIL & GREASE     .00   PO4      11.97
   TEMP (S)    23.0 C     CATIONS      160.00
   PH             7.6     ANIONS       160.00

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   SPLIT AND MERGE EXAMPLE                            PRESENT   1  TRAIN NO   1

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TANK 1 CONTENTS REPLACES LIQUID LINE CONTENTS

LIQUID LINE NOW CONTAINS:


                        LIQUID CHARACTERISTICS
FLOW       (MGD)     SOLIDS    (MG/L)               (MG/L)          (MG/L)
MAXIMUM    2.5000    SUSPENDED  200.00     BOD5     300.00       TKN 45.00
AVERAGE    2.5000    VOLATILE    60.00 %   BOD5S     75.00       NH3 25.00
MINIMUM    2.5000    SETTLEABLE  15.00     COD      500.00       NO2   .00
                                           CODS     400.00       NO3   .00
TEMP (W)   10.0 C    OIL & GREASE    .00   PO4       18.00
TEMP (S)   23.0 C    CATIONS      160.00
PH            7.6    ANIONS       160.00

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   SPLIT AND MERGE EXAMPLE                            PRESENT   1  TRAIN NO   1

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PRIMARY CLARIFIER

 CIRCULAR CLARIFIER

D SURFACE OVERFLOW RATE                 .100+04 GAL/DAY/SQFT
  SURFACE AREA                          .250+04 SQ FT
D SIDE WATER DEPTH                      .900+01 FEET
  DETENTION TIME                        .162+01 HOURS
  SOLID LOADING                         .167+01 LB/SQFT/DAY
D WEIR LOADING                          .150+05 GAL/DAY/FT
  WEIR LENGTH                           .167+03 FEET
  VOLUME OF SLUDGE PRODUCED             .690+04 GAL/DAY
D SUSPENDED SOLIDS REMOVAL              .580+02 PERCENT
D BOD REMOVAL                           .320+02 PERCENT
D COD REMOVAL                           .400+02 PERCENT
D TKN REMOVAL                           .500+01 PERCENT
D PO4 REMOVAL                           .500+01 PERCENT

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   SPLIT AND MERGE EXAMPLE                          PRESENT   1  TRAIN NO   1

QUANTITIES FOR SEDIMENTATION

CIRCULAR CLARIFIER

PRIMARY CLARIFIER
EXCESS CAPACITY FACTOR                                .130+01
CALCULATED SURFACE AREA                               .250+04 SQ FT
ADJUSTED SURFACE AREA                                 .250+04 SQ FT
AVERAGE DAILY WASTEWATER FLOW                         .250+01 MGD
NUMBER OF CIRCULAR CLARIFIERS                               2
NUMBER OF BATTERIES                                         1
SURFACE AREA PER UNIT                                 .125+04 SQ FT
DIAMETER OF UNIT                                      .400+02 FEET
EARTHWORK REQUIRED                                    .310+05 CU FT
SIDEWATER DEPTH                                       .900+01 FEET
THICKNESS OF THE SLAB                                 .101+02 INCHES
WALL THICKNESS                                        .115+02 INCHES
TOTAL  WALL CONCRETE REQUIRED                         .275+04 CU FT
TOTAL SLAB CONCRETE REQUIRED                          .270+04 CU FT
MAINTENANCE MANPOWER REQUIRED                         .257+03 MAN-HOURS/YR
OPERATION MANPOWER REQUIRED                           .471+03 MAN-HOURS/YR
ELECTRICAL ENERGY REQUIRED                            .802+04 KWHR/YR


                       LIQUID CHARACTERISTICS
FLOW       (MGD)     SOLIDS     (MG/L)                (MG/L)         (MG/L)
MAXIMUM    2.5000    SUSPENDED   84.00     BOD5     204.00      TKN 42.75
AVERAGE    2.5000    VOLATILE    60.00 %   BOD5S     75.00      NH3 25.00
MINIMUM    2.5000    SETTLEABLE    .00     COD      400.00      NO2   .00
                                           CODS     400.00      NO3   .00
TEMP (W)   10.0 C    OIL & GREASE    .00   PO4       17.10
TEMP (S)   23.0 C    CATIONS      160.00
PH           7.6     ANIONS       160.00


                          SLUDGE CHARACTERISTICS
                          PRIMARY         SECONDARY
   VOLUME (GAL/D)        27619.05          89126.21
      % SOLIDS               4.00              1.00
      % VOLATILE            60.00             70.00
   SPLIT AND MERGE EXAMPLE                       PRESENT   1  TRAIN NO   1

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COMPLETE MIX ACTIVATED SLUDGE

D REACTION RATE CONSTANT                    .135-02 L/MG-H
D SLUDGE PRODUCED PER BOD REMOVED           .730+00
D ENDOGENEOUS RATE  (OXYGEN BASIS)          .150+00 /DAY
D O2 UTILIZED PER BOD REMOVED               .520+00
D ENDOGENEOUS RATE  (SLUDGE BASIS)          .750-01 /DAY
D INFLUENT NON-DEGRADABLE VSS               .400+00
D EFFLUENT DEGRADABLE VSS                   .530+00
D LB BOD/LB MLSS-DAY                        .500+00
D MIXED LIQUOR SS                           .450+04 MG/L
D MIXED LIQUOR VS                           .315+04 MG/L
  AERATION TIME                             .644+01 HOURS
  VOLUME OF AERATION TANK                   .670+00 MG
  OXYGEN REQUIRED                           .532+04 LB/DAY
  SLUDGE PRODUCED                           .255+04 LB/DAY
  NITROGEN REQUIREMENT                      .970+01 MG/L
  PHOSPHOROUS REQUIREMENT                   .194+01 MG/L
  SLUDGE RECYCLE RATIO                      .818+02 PERCENT
  SOLIDS RETENTION TIME                     .986+01 DAYS
  VOLUMETRIC LOADING                        .475+02 LB BOD/TCFT

DIFFUSED AERATION SYSTEM

D STANDARD TRANSFER EFFICIENCY              .600+01 PERCENT
  OPERATING EFFICIENCY                      .357+01 PERCENT
  REQUIRED AIR FLOW                         .656+02 CFM/TCFT

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   SPLIT AND MERGE EXAMPLE                       PRESENT   1  TRAIN NO   1

QUANTITIES FOR DIFFUSED AERATION SYSTEM

COMPLETELY MIXED FLOW
AVERAGE DAILY WASTEWATER FLOW                       .250+01 MGD
TOTAL NUMBER OF TANKS                                     3
NUMBER OF BATTERIES                                       1
ACTUAL VOLUME PER TANK                              .299+05 CU FT
PROCESS AIR REQUIREMENT                             .588+04 SCFM
NUMBER OF DIFFUSERS PER TANK                            164
NUMBER OF SWING ARM HEADERS PER TANK                      3
LENGTH OF AERATION TANKS                            .664+02 FEET
PIPE GALLERY WIDTH                                  .210+02 FEET
VOLUME OF EARTHWORK REQUIRED                        .599+05 CU FT
REINFORCED SLAB CONCRETE REQUIRED                   .138+05 CU FT
REINFORCED WALL CONCRETE REQUIRED                   .120+05 CU FT
HANDRAIL LENGTH                                     .717+03 FEET
OPERATION MANPOWER REQUIRED                         .210+04 MAN-HRS/YEAR
MAINTENANCE MANPOWER REQUIRED                       .114+04 MAN-HRS/YEAR
ELECTRICAL ENERGY REQUIRED                          .142+07 KWHR/YEAR
O & M MATERIAL AND SUPPLY COST                      .281+01 PERCENT
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   SPLIT AND MERGE EXAMPLE                      PRESENT    1   TRAIN NO    1

QUANTITIES FOR RECYCLE PUMPING

AVERAGE DAILY PUMPING RATE                     .250+01 MGD
TOTAL PUMPING CAPACITY                         .250+01 MGD
DESIGN CAPACITY PER PUMP                       .868+03 GPM
NUMBER OF PUMPS                                      3
NUMBER OF BATTERIES                                  1
AREA OF PUMP BUILDING                          .249+03 SQ FT
VOLUME OF EARTHWORK REQUIRED                   .199+04 CU FT
FIRM PUMPING CAPACITY                          .250+01 MGD
OPERATING MANPOWER REQUIRED                    .495+03 MAN-HOURS/YR
MAINTENANCE MANPOWER REQUIRED                  .412+03 MAN-HOURS/YR
ELECTRICAL ENERGY REQUIRED                     .167+06 KWHR/YR
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   SPLIT AND MERGE EXAMPLE                      PRESENT    1   TRAIN NO    1

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SECONDARY CLARIFIER FOR ACTIVATED SLUDGE

 CIRCULAR CLARIFIER

  SOLIDS LOADING RATE                  .188+02 LB/SQFT/DAY
  SURFACE AREA                         .500+04 SQ FT
D SURFACE OVERFLOW RATE                .500+03 GAL/SQFT/DAY
  DETENTION TIME                       .323+01 HOURS
D WEIR OVERFLOW RATE                   .150+05 GAL/FT/DAY
D TANK SIDEWATER DEPTH                 .900+01 FEET
  WEIR LENGTH                          .167+03 FEET
  VOLUME OF WASTED SLUDGE              .297+05 GAL/DAY
D UNDERFLOW CONCENTRATION              .100+01 PERCENT

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    SPLIT AND MERGE EXAMPLE                                PRESENT   1  TRAIN NO   1

   QUANTITIES FOR SEDIMENTATION

   CIRCULAR CLARIFIER

   SECONDARY CLARIFIER
   EXCESS CAPACITY FACTOR                          .100+01
   CALCULATED SURFACE AREA                         .500+04 SQ FT
   ADJUSTED SURFACE AREA                           .500+04 SQ FT
   AVERAGE DAILY WASTEWATER FLOW                   .250+01 MGD
   NUMBER OF CIRCULAR CLARIFIERS                         2
   NUMBER OF BATTERIES                                   1
   SURFACE AREA PER UNIT                           .250+04 SQ FT
   DIAMETER OF UNIT                                .570+02 FEET
   EARTHWORK REQUIRED                              .623+05 CU FT
   SIDEWATER DEPTH                                 .900+01 FEET
   THICKNESS OF THE SLAB                           .101+02 INCHES
   WALL THICKNESS                                  .115+02 INCHES
   TOTAL  WALL CONCRETE REQUIRED                   .382+04 CU FT
   TOTAL SLAB CONCRETE REQUIRED                    .519+04 CU FT
   MAINTENANCE MANPOWER REQUIRED                   .369+03 MAN-HOURS/YR
   OPERATION MANPOWER REQUIRED                     .674+03 MAN-HOURS/YR
   ELECTRICAL ENERGY REQUIRED                      .900+04 KWHR/YR


                              LIQUID CHARACTERISTICS
   FLOW        (MGD)      SOLIDS      (MG/L)                 (MG/L)         (MG/L)
   MAXIMUM     2.5000     SUSPENDED    20.00      BOD5      15.34      TKN 29.92
   AVERAGE     2.5000     VOLATILE     70.00 %    BOD5S     10.00      NH3 29.92
   MINIMUM     2.5000     SETTLEABLE     .00      COD       23.01      NO2    .00
                                                  CODS      15.00      NO3    .00
   TEMP (W)    10.0 C     OIL & GREASE     .00    PO4       11.97
   TEMP (S)    23.0 C     CATIONS       160.00
   PH           7.6       ANIONS        160.00


                                SLUDGE CHARACTERISTICS
                                PRIMARY            SECONDARY
      VOLUME (GAL/D)           27619.05            118834.95
        % SOLIDS                   4.00                 1.00
        % VOLATILE                60.00                70.00

    SPLIT AND MERGE EXAMPLE                                PRESENT   1  TRAIN NO   1

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  TANK 2 MIXED INTO LIQUID LINE

  LIQUID LINE NOW CONTAINS:


                              LIQUID CHARACTERISTICS
   FLOW        (MGD)      SOLIDS      (MG/L)                 (MG/L)         (MG/L)
   MAXIMUM    10.0000     SUSPENDED    20.00      BOD5      15.34      TKN 29.92
   AVERAGE    10.0000     VOLATILE     70.00 %    BOD5S     10.00      NH3 29.92
   MINIMUM    10.0000     SETTLEABLE     .00      COD       23.01      NO2    .00
                                                  CODS      15.00      NO3    .00
   TEMP (W)    10.0 C     OIL & GREASE     .00    PO4       11.97
   TEMP (S)    23.0 C     CATIONS       160.00
   PH           7.6       ANIONS        160.00

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   SPLIT AND MERGE EXAMPLE                              PRESENT   1  TRAIN NO   1

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CHLORINATION

   MAXIMUM FLOW                                   .100+02 MGD
   AVERAGE FLOW                                   .100+02 MGD
D  CONTACT TIME                                   .300+02 MIN
   TOTAL VOLUME                                   .208+06 GAL
   AVERAGE CHLORINE REQUIREMENT                   .834+03 LB/DAY
   PEAK CHLORINE REQUIREMENT                      .834+03 LB/DAY
   COLIFORM REDUCTION                             .996+02 PERCENT

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   SPLIT AND MERGE EXAMPLE                             PRESENT   1  TRAIN NO   1

QUANTITIES FOR CHLORINATION

NUMBER OF CHLORINATORS AND EVAPORATORS              1
CHLORINATION BUILDING AREA                   .220+03 SQ FT
NUMBER OF CHLORINE CYLINDERS                       13
AREA OF CHLORINE STORAGE BUILDING            .182+04 SQ FT
AVERAGE DAILY WASTEWATER FLOW MGD            .100+02 MGD
VOLUME OF EARTHWORK REQUIRED                 .144+05 CU FT
VOLUME OF WALL CONCRETE                      .565+04 CU FT
VOLUME OF SLAB CONCRETE                      .307+04 CU FT
CHLORINE REQUIREMENT PER YEAR                .152+03 TONS/YR
OPERATIONAL LABOR                            .145+04 MAN-HOURS/YR
MAINTENANCE MANPOWER REQUIRED                .363+03 MAN-HOURS/YR
ELECTRICAL ENERGY REQUIRED                   .131+06 KWHR/YR
CHLORINE REQUIREMENT                         .834+03 LBS/DAY
O & M MATERIAL AND SUPPLY COSTS              .313+01 PERCENT


                          LIQUID CHARACTERISTICS
FLOW        (MGD)       SOLIDS     (MG/L)              (MG/L)        (MG/L)
MAXIMUM   10.0000       SUSPENDED    20.00    BOD5      15.34      TKN 29.92
AVERAGE   10.0000       VOLATILE     70.00 %  BOD5S     10.00      NH3 29.92
MINIMUM   10.0000       SETTLEABLE     .00    COD       23.01      NO2   .00
                                              CODS      15.00      NO3   .00
TEMP (W)   10.0 C       OIL & GREASE     .00  PO4       11.97
TEMP (S)   23.0 C       CATIONS       160.00
PH            7.6       ANIONS        160.00


                           SLUDGE CHARACTERISTICS
                           PRIMARY           SECONDARY
   VOLUME (GAL/D)         27619.05           118834.95
     % SOLIDS                 4.00                1.00
     % VOLATILE              60.00               70.00
   SPLIT AND MERGE EXAMPLE                            PRESENT   1  TRAIN NO   1

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 FILTRATION

   LAYER      DEPTH     DIAMETER  SHAPE     SPECIFIC
               (FT)      (FT)     FACTOR    GRAVITY
 D      1    1.0000       .0046    7.00       1.40
 D      2    1.0000       .0020    8.50       2.65
 D      3    1.0000       .0010    8.00       2.65
 D      4    1.0000       .0500    6.00       2.65

 D AVERAGE LOADING RATE                  .600+01 GPM/SQFT
   SURFACE AREA                          .116+04 SQ FT
 D UNDERDRAIN HEADLOSS                   .100+01 FEET
 D WASHWATER GUTTER WIDTH                .100+01 FEET
   WASHWATER GUTTER DEPTH                .517+00 FEET
   TERMINAL HEADLOSS THROUGH BED         .208+01 FEET
   MAXIMUM HEAD FOR BACKWASHING          .956+01 FEET
   TOTAL FILTER DEPTH                    .900+01 FEET
   WASHWATER NEEDED                      .185+06 GAL
   BACKWASH RATE                         .200+02 GPM/SQFT

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   SPLIT AND MERGE EXAMPLE                            PRESENT   1  TRAIN NO   1

 QUANTITIES FOR FILTRATION

 SURFACE AREA PER FILTER                            .185+04 SQ FT
 EARTHWORK FOR A SINGLE FILTER                      .217+05 CU FT
 NUMBER OF FILTER UNITS PER BATTERY                       1
 NUMBER OF CELLS PER UNIT                                 4
 NUMBER BATTERIES                                         1
 TOTAL EARTHWORK FOR MULTIPLE FILTERS               .217+05 CU FT
 REINFORCED CONCRETE FOR SINGLE FILTER              .110+05 CU FT
 REINFORCED CONCRETE FOR MULTIPLE FILTERS           .110+05 CU FT
 VOLUME SURGE TANK                                  .248+05 CU FT
 WIDTH SURGE TANK                                   .421+02 FEET
 LENGTH SURGE TANK                                  .841+02 FEET
 EARTHWORK SURGE TANK                               .516+05 CU FT
 REINFORCED CONCRETE FOR SURGE TANK                 .635+04 CU FT
 AVERAGE WASTEWATER DESIGN FLOW                     .100+02 MGD
 ELECTRICAL ENERGY REQUIRED                         .770+05 KWHR/YR
 OPERATION MAN-HOURS                                .300+03 MAN-HOURS/YR
 MAINTENANCE MAN-HOURS                              .208+03 MAN-HOURS/YR


                             LIQUID CHARACTERISTICS
 FLOW       (MGD)       SOLIDS     (MG/L)               (MG/L)           (MG/L)
 MAXIMUM   10.0000      SUSPENDED     8.00     BOD5      10.00        TKN 29.92
 AVERAGE   10.0000      VOLATILE     70.00 %   BOD5S     10.00        NH3 29.92
 MINIMUM   10.0000      SETTLEABLE     .00     COD       15.00        NO2   .00
                                               CODS      15.00        NO3   .00
 TEMP (W)   10.0 C      OIL & GREASE     .00   PO4       11.97
 TEMP (S)   23.0 C      CATIONS       160.00
 PH          7.6        ANIONS        160.00

                              SLUDGE CHARACTERISTICS
                              PRIMARY          SECONDARY
   VOLUME (GAL/D)            27619.05          118834.95
     % SOLIDS                    4.00               1.00
     % VOLATILE                 60.00              70.00
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  SPLIT AND MERGE EXAMPLE                              PRESENT   1  TRAIN NO   1

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**** SECONDARY SLUDGE LINE MIXED INTO PRIMARY SLUDGE LINE ****


                                   INFLUENT


                              LIQUID CHARACTERISTICS
FLOW         (MGD)      SOLIDS     (MG/L)             (MG/L)          (MG/L)
MAXIMUM   10.0000      SUSPENDED      8.00    BOD5     10.00      TKN 29.92
AVERAGE   10.0000      VOLATILE      70.00 %  BOD5S    10.00      NH3 29.92
MINIMUM   10.0000      SETTLEABLE      .00    COD      15.00      NO2    .00
                                              CODS     15.00      NO3    .00
TEMP (W)   10.0 C      OIL & GREASE      .00  PO4      11.97
TEMP (S)   23.0 C      CATIONS      160.00
PH            7.6      ANIONS       160.00


                              SLUDGE CHARACTERISTICS
                              PRIMARY          SECONDARY
   VOLUME (GAL/D)          146454.00                .00
      % SOLIDS                  1.57                .00
      % VOLATILE               65.18                .00
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  SPLIT AND MERGE EXAMPLE                              PRESENT   1  TRAIN NO   1

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AEROBIC DIGESTION

  RAW SLUDGE SPECIFIC GRAVITY          .105+01
D DETENTION TIME                       .180+02 DAYS
D VOLATILE SOLIDS DESTROYED            .400+02 PERCENT
D MIXED LIQUOR SOLIDS                  .120+05 MG/L
D SOLIDS IN DIGESTED SLUDGE            .250+01 PERCENT
D ALPHA                                .900+00
D BETA                                 .900+00
D STANDARD TRANSFER EFFICIENCY         .600+01 PERCENT
  DIGESTER VOLUME                      .264+07 GAL
  VOLATILE SOLIDS LOADING              .371-01 LB VS/CUFT/DAY
  SOLIDS ACCUMULATED PER DAY           .111+05 LB/DAY
  DIGESTER CAPACITY                    .264+06 LB
  VOLUME OF WASTED SLUDGE              .121+07 GAL
  SOLIDS RETENTION TIME                .237+02 DAYS
  OXYGEN REQUIREMENT                   .105+05 LB/DAY
  AIR SUPPLY                           .332+02 CFM/TCFT

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   SPLIT AND MERGE EXAMPLE                        PRESENT   1  TRAIN NO   1

QUANTITIES FOR DIFFUSED AERATION SYSTEM

COMPLETELY MIXED FLOW
AVERAGE DAILY WASTEWATER FLOW                .146+00 MGD
TOTAL NUMBER OF TANKS                              2
NUMBER OF BATTERIES                                1
ACTUAL VOLUME PER TANK                       .176+06 CU FT
PROCESS AIR REQUIREMENT                      .117+05 SCFM
NUMBER OF DIFFUSERS PER TANK                     488
NUMBER OF SWING ARM HEADERS PER TANK              16
LENGTH OF AERATION TANKS                     .392+03 FEET
PIPE GALLERY WIDTH                           .201+02 FEET
VOLUME OF EARTHWORK REQUIRED                 .204+06 CU FT
REINFORCED SLAB CONCRETE REQUIRED            .481+05 CU FT
REINFORCED WALL CONCRETE REQUIRED            .377+05 CU FT
HANDRAIL LENGTH                              .247+04 FEET
OPERATION MANPOWER REQUIRED                  .298+04 MAN-HRS/YEAR
MAINTENANCE MANPOWER REQUIRED                .173+04 MAN-HRS/YEAR
ELECTRICAL ENERGY REQUIRED                   .668+06 KWHR/YEAR
O & M MATERIAL AND SUPPLY COST               .213+01 PERCENT


                        LIQUID CHARACTERISTICS
FLOW       (MGD)      SOLIDS    (MG/L)               (MG/L)        (MG/L)
MAXIMUM  10.0000      SUSPENDED     8.00   BOD5      10.00     TKN 29.92
AVERAGE  10.0000      VOLATILE     70.00 %  BOD5S    10.00     NH3 29.92
MINIMUM  10.0000      SETTLEABLE     .00   COD       15.00     NO2    .00
                                           CODS      15.00     NO3    .00
TEMP (W)   10.0 C     OIL & GREASE    .00  PO4       11.97
TEMP (S)   23.0 C     CATIONS      160.00
PH          7.6       ANIONS       160.00

                          SLUDGE CHARACTERISTICS
                          PRIMARY         SECONDARY
     VOLUME (GAL/D)      50856.92              .00
        % SOLIDS             2.50              .00
        % VOLATILE          52.90              .00




   SPLIT AND MERGE EXAMPLE                        PRESENT   1  TRAIN NO   1

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SLUDGE DRYING BEDS

  TOTAL SURFACE AREA REQUIRED    .104+06 SQ FT
D INITIAL DEPTH OF SLUDGE        .120+02 INCHES
D FINAL PERCENT SOLIDS           .500+02
  BED HOLDING TIME               .152+02 DAYS

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  SPLIT AND MERGE EXAMPLE                          PRESENT   1  TRAIN NO   1

QUANTITIES FOR DRYING BED

TOTAL DRYING BED SURFACE AREA                      .104+06 SQ FT
NUMBER BEDS                                              35
SURFACE AREA OF EACH INDIVIDUAL BED                .296+04 SQ FT
LENGTH OF EACH BED                                 .148+03 FEET
VOLUME OF EARTHWORK REQUIRED                       .510+06 CU FT
VOLUME CONCRETE FOR DIVIDING WALL                  .340+05 CU FT
VOLUME OF R.C. IN-PLACE FOR TRUCK TRACKS           .155+05 CU FT
VOLUME OF SAND                                     .777+05 CU FT
VOLUME OF GRAVEL                                   .104+06 CU FT
CLAY PIPE DIAMETER                                 .600+01 INCHES
TOTAL LENGTH CLAY PIPE                             .104+05 FEET
SLUDGE SOLIDS PER DAY                              .530+01 TONS/DAY
OPERATION MANPOWER REQUIRED                        .565+04 MAN-HOURS/YR
MAINTENANCE MANPOWER REQUIRED                      .282+04 MAN-HOURS/YR


                         LIQUID CHARACTERISTICS
FLOW       (MGD)      SOLIDS     (MG/L)               (MG/L)        (MG/L)
MAXIMUM  10.0000      SUSPENDED     8.00     BOD5     10.00     TKN 29.92
AVERAGE  10.0000      VOLATILE     70.00 %   BOD5S    10.00     NH3 29.92
MINIMUM  10.0000      SETTLEABLE     .00     COD      15.00     NO2   .00
                                             CODS     15.00     NO3   .00
TEMP (W)   10.0 C     OIL & GREASE    .00    PO4      11.97
TEMP (S)   23.0 C     CATIONS      160.00
PH          7.6       ANIONS       160.00

                          SLUDGE CHARACTERISTICS
                          PRIMARY         SECONDARY
   VOLUME (GAL/D)        2542.85               .00
     % SOLIDS              50.00               .00
     % VOLATILE            52.90               .00
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  SPLIT AND MERGE EXAMPLE                          PRESENT   1  TRAIN NO   1

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SLUDGE HAULING AND LAND FILLING

  VOLUME OF SLUDGE HAULED                   .126+02 CUYD/DAY
  TRUCK CAPACITY                            .190+02 CU YD
D ROUND TRIP TIME TO DISPOSAL SITE          .100+01 HRS
D TRUCK LOADING TIME                        .750+00 HRS
D HOURS OF OPERATION PER DAY                .800+01 HRS
  NUMBER OF TRUCKS REQUIRED                       1
  TONS OF SLUDGE HAULED PER DAY             .111+02 TONS/DAY
D DISTANCE TO DISPOSAL SITE                 .100+02 MILES

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   SPLIT AND MERGE EXAMPLE                     PRESENT   1  TRAIN NO   1

QUANTITIES FOR SLUDGE HAULING AND LANDFILL

TOTAL SLUDGE VOLUME HAULED                    .126+02 CUYD/DAY
MAXIMUM ANTICIPATED LANDFILL DOWNTIME         .300+02 DAYS
ANTICIPATED SLUDGE STORAGE HEIGHT             .800+01 FEET
SLUDGE STORAGE SHED AREA                      .127+04 SQ FT
WIDTH OF SLUDGE STORAGE SHED SLAB             .252+02 FEET
LENGTH OF SLUDGE STORAGE SHED SLAB            .505+02 FEET
VOLUME OF EARTHWORK                           .368+04 CU FT
VOLUME OF SLAB CONCRETE                       .162+04 CU FT
SURFACE AREA OF CANOPY ROOF                   .127+04 SQ FT
DISTANCE TO DISPOSAL SITE                     .100+02 MILES
ROUND TRIP HAUL DISTANCE                      .200+02 MILES
TONS OF SLUDGE HAULED PER DAY                 .111+02 TONS/DAY
OPERATION MANPOWER REQUIRED                   .197+03 MAN-HOURS/YR
ROUND TRIPS PER DAY PER TRUCK                 .100+01
DISTANCE TRAVELED PER YEAR PER TRUCK          .500+04 MILES/YR
MAINTENANCE AND MATERIAL SUPPLY COST          .650+01 PERCENT


                       LIQUID CHARACTERISTICS
FLOW      (MGD)     SOLIDS     (MG/L)               (MG/L)       (MG/L)
MAXIMUM  10.0000    SUSPENDED     8.00    BOD5     10.00    TKN 29.92
AVERAGE  10.0000    VOLATILE     70.00 %  BOD5S    10.00    NH3 29.92
MINIMUM  10.0000    SETTLEABLE     .00    COD      15.00    NO2   .00
                                          CODS     15.00    NO3   .00
TEMP (W)  10.0 C    OIL & GREASE     .00  PO4      11.97
TEMP (S)  23.0 C    CATIONS       160.00
PH         7.6      ANIONS        160.00

                         SLUDGE CHARACTERISTICS
                         PRIMARY        SECONDARY
   VOLUME (GAL/D)           .00               .00
     % SOLIDS               .00               .00
     % VOLATILE             .00               .00
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   SPLIT AND MERGE EXAMPLE                     PRESENT   1  TRAIN NO   1

QUANTITIES FOR BLOWERS

DESIGN CAPACITY FOR BLOWER SYSTEM             .352+05 SCFM
NUMBER OF BLOWERS FOR MAX AIR REQUIREMENTS          2
CAPACITY OF INDIVIDUAL BLOWERS                .176+05 SCFM
TOTAL NUMBER OF BLOWERS REQUIRED                    3
BLOWER BUILDING AREA                          .187+04 SQ FT
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  SPLIT AND MERGE EXAMPLE                          PRESENT   1  TRAIN NO   1

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LIQUID    PREL  0  L SP  2  PRIM  0  COMP  0  L ST  3  L RE  0  PRIM  1  COMP  1  L ME  0  CHLO  0
          FILT  0
SECONDARY A MI  0
PRIMARY   AERO  0  DRYI  0  HAUL  0

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                                   COST SUMMARY

                                   OPLR      MAINT                                            TOTAL
             CAPITAL    AMMORT     LABOR     LABOR       POWER    MATERIAL    CHEMICAL        O & M
  UNIT       COST        COST      COST      COST        COST       COST        COST          COST
               $         $/YR      $/YR      $/YR        $/YR       $/YR        $/YR          $/YR
PRELIMIN*    159346     11909     13915      6070        1859       3983           0         25827
PRIM CLA          0         0       727       635         999        500           0          2861
COMP MIX          0         0      7274      6356       99999      20000           0        133629
A SEC CL     489714     36602      9503      4587         432       4897           0         19419
RCY PUMP          0         0         0         0           0          0           0             0
PRIM CLA     179146     13389      3423      1634         320       1791           0          7168
COMP MIX     360455     27139     15306      7249       56779      10138           0         89472
A SEC CL     260818     19494      4905      2347         360       2608           0         10220
RCY PUMP      90600      7503      3600      2620        6685        634           0         13539
CHLORINA          0         0       727       635        2499       3000           0          6861
FILTRATI     784247     68905      2183      1320        3080      22041           0         25624
AERO DIG    1207584     90944     21664     10992       26721      25669           0         85046
DRY BEDS     474569     36159     41131     17955           0       4271           0         63357
HAUL SLF      81130     12297      1432         0           0      11054           0         12486
BLOWERS      498766     37278         0         0           0          0           0             0

SUB TOTAL   4586379    361626    125798     62405      199738     110590           0        498509

* WARNING - COST ESTIMATES ARE FROM PARAMETRIC EQUATIONS

DIRECT COSTS
 PROFIT/OVERHEAD                  1009003 $

   SUB TOTAL (OTHER DIRECT)       1009003 $          TOTAL CONSTRUCTION COST   5595382 $

INDIRECT COSTS
 MISC NON CONST COSTS              279769 $
 ADMIN/LEGAL                       111907 $
 201 PLANNING                      195838 $
 A/E DESIGN FEE                    346321 $
 INSPECTION                        111907 $
 CONTINGENCIES                     447630 $
 TECHNICAL COSTS                   111907 $

   SUB TOTAL (INDIRECT)           1605279 $


LAND COSTS                          20600 $     (   20. ACRES)
INTEREST DURING CONSTRUCTION       717553 $

ADMINISTRATIVE COST                 28414 $/YR
LABORATORY COST                     28649 $/YR

TOTAL PROJECT COST   7938214 $     TOTAL CONSTRUCTION COST    5595382 $
FINAL YEAR O & M      555596 $/YR  TOTAL STEP III COST        7396055 $
INITIAL YEAR O & M    455727 $/YR  PRESENT WORTH (APP. A)    14930232 $
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   SPLIT AND MERGE EXAMPLE                         PRESENT   1  TRAIN NO   1

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USER CHARGE SUMMARY

D EPA GRANT                                                   .750+02 PERCENT
D STATE GRANT                                                 .000    PERCENT
D ALLOWANCE FOR FINANCING                                     .300+01 PERCENT
  BONDS                   PERCENT  RATE  LIFE
D   REVENUE               100.00 10.00    30
D   GENERAL OBLIGATION       .00   .00    30
D   OTHER                    .00   .00    30
D EXISTING SEWER RATE                                         .000    $/TGAL
D PERSONS PER HOUSEHOLD                                       .350+01
D GALLONS/CAPITA/DAY (WATER USE)                              .100+03 GPCPD
  TOTAL PROJECT COST                                          .794+07 $
  EPA ELIGIBLE COST                                           .792+07 $
  LOCAL SHARE                                                 .206+07 $
  ANNUAL DEBT SERVICE                                         .218+06 $/YEAR
  PRINCIPAL AND INTEREST RESERVE                              .312+05 $/YEAR
  CONTINGENCY RESERVE                                         .312+05 $/YEAR
  TOTAL ANNUAL OPERATING COST                                 .836+06 $/YEAR
  TREATMENT COST
    COST PER 1000 GALLONS TREATED (NEW SYSTEM)                .229+00 $/TGAL
    COST PER 1000 GALLONS TREATED (TOTAL SYSTEM)              .229+00 $/TGAL
    COST PER BILLING UNIT (NEW SYSTEM)                        .458+00 $/TGAL
    COST PER BILLING UNIT (TOTAL SYSTEM)                      .458+00 $/TGAL
    COST PER HOUSEHOLD (NEW SYSTEM)                           .481+01 $/MONTH
    COST PER HOUSEHOLD (TOTAL SYSTEM)                         .481+01 $/MONTH
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APPENDIX F

REPLACEMENT SCHEDULES

Calculation of present worth requires consideration of the variable service lives of equipment and structures. This section provides an explanation of the various data entries found on the REPLACEMENT card in the unit process specification. In general, it is expected that reasonable changes in the equipment and structural component service lives will have only a nominal effect on treatment alternative cost-effectiveness. If the user desires to exclude salvage value from the calculations, each service life variable can be set equal to the planning period.

a. Parametic unit processes:

Unit Processes	Key Word	Cost Item	Replacement Schedule (years)
Activated Sludge Units			
Complete Mix	COMPLE	Mechanical Aerator (RSSA)	20
Contact Stabilization	CONTAC	Diffuser (RSPD)	30
Extended Aeration	EXTEND	Swing Arm Diffuser (RSPH)	30
High Rate	HIGH R	Pump (RSPS)	25
Plug Flow	PLUG F	Structural (RSST)	40
Air Flotation	AIR FL	Air Flotation Unit (RSFS)	30
		Structural (RSST)	40
Aerated Lagoon	AERATE	Mechanical Aerator (RSSA)	15
		Liner (RSLL)	15
		Structural (RSST)	40
Aerobic Digestion	AEROBI	Mechanical Aerator (RSSA)	20
		Diffuser (RSPD)	30
		Swing Arm Diffuser (RSPH)	30
		Structural (RSST)	40
Anaerobic Digestion	ANAERO	Floating Cover (RSCO)	30
		Gas Circulation Unit (RSUS)	30
		Heating Unit (RSXS)	30
		Gas Safety Equipment (RSES)	30
		Sludge Pump (RSMP)	25
		Structural (RSST)	40
Anion Exchange	ANION	Capital Cost (RSST)	40
Belt Filtration	BELT F	Capital Cost (RSST)	
Blowers	None	Rotary Blower (RSBS)	40
		Multistage Centrifugal Blower (RSBM)	40
		Single-Stage Centrifugal Blower (RSBS)	40
Carbon Adsorption	CARBON	Underdrain System (RSUD)	15
		Control Gate Unit (RSCG)	15
		Furnace Unit (RSSF)	15
		Pump (RSPS)	25
		Structural (RSST)	40
Cation Exchange	CATION	Capital (RSST)	40
Centrifugation	CENTRI	Centrifuge (RSSC)	18
		Structural (RSST)	40
Chemical Feed Systems (Service life cannot be changed)	None	Alum System	40
		Iron Salts System	40
		Lime System	40
		Polymer System	40
Chlorination	CHLORI	Chlorinator (RSLE)	15
		Structural (RSST)	40

Unit Processes	Key Word	Cost Item	Replacement Schedule (years)
Coagulation	COAGUL	Upflow Clarifier (RSCL)	40
		Structural (RSST)	40
Comminution	COMMIN	Capital Cost (RSST)	40
Counter Current Ammonia Stripping	COUNTE	Capital Cost (RSST)	40
Cross Current Ammonia Stripping	CROSS	Capital Cost (RSST)	40
Denitrification Suspended Growth	DENITR	Mechanical Aerator (RSSA)	20
		Turbine Mixer (RSXM)	20
		Pump (RSPS)	25
		Structural (RSST)	40
Attached Growth	ATTACH	Distribution System (RSCD)	25
		Pump (RSPS)	25
		Structural (RSST)	40
Drying Beds	DRYING	4-in. Pipe (RSCP)	20
		6-in. Pipe (RSCP)	20
		8-in. Pipe (RSCP)	20
		Structural (RSST)	40
Dummy	DUMMY	Capital Cost (RSST)	--
Equalization	EQUALI	Floating Aerator (RSSA)	15
		Liner (RSLL)	15
		Structural (RSST)	40
Filter Press	FLTR P	Capital Cost (RSST)	40
Filtration	FILTRA	Filter Unit (RSSF)	20
		Pump (RSPS)	25
		Package Filter Unit (RSSF)	20
		Structural (RSST)	40
Flocculation	FLOCCU	Capital Cost (RSST)	40
Flotation Thickening	FLOTAT	Flotation Unit (RSFS)	30
		Structural (RSST)	40
Fluidized Bed Incineration	FLUIDI	Incinerator (RSFI)	30
		Structural (RSST)	40
Gravity Thickening	GRAVIT	Thickener (RSTS)	40
		Structural (RSST)	40
Grit Removal	GRIT R	Capital Cost (RSST)	40
Sludge Hauling and Land Filling	HAULIN	Vehicle (RSSV)	6
		Structural (RSST)	40
Lagoon	LAGOON	Steel Pipe (RSSP)	20
		Butterfly Valve (RSSV)	20
		Liner (RSLL)	15
		Structural (RSST)	40
Microscreening	MICROS	Microscreen (RSSM)	15
		Structural (RSST)	40

Unit Processes	Key Word	Cost Item	Replacement Schedule (years)
Multiple Hearth Incineration	MULTIP	Incinerator (RSIS)	30
		Structural (RSST)	40
Neutralization	NEUTRA	Capital Cost (RSST)	40
Nitrification Suspended Growth	NITRIF	Mechanical Aerator (RSSA)	20
		Diffuser (RSPD)	30
		Swing Arm Diffuser (RSPH)	30
		Pump (RSPS)	25
		Structural (RSST)	40
Nitrification - RBC	N RBC	RBC Unit (RSES)	15
		Structural (RSST)	40
Nitrification - Trickling Filter	N TRIC	Media (RSFM)	40
		Distributor Arm (RSAS)	40
		Pump (RSPS)	25
		Structural (RSST)	40
Overland Flow Land Treatment	OVERLA	Pump (RSPS)	25
		Steel Pipe (RSSP)	20
		Butterfly Valve (RSSV)	20
		Sprinkler (RSSV)	20
		Liner (RSLL)	15
		Embankment Protection (RSBA)	40
		Fence (RSFN)	15
		Water Well (RSMW)	20
		Concrete Drainpipe (RSSC)	20
		Structural (RSST)	40
Oxidation Ditch	OXIDAT	Rotor Mechanism (RSDS)	15
		Pump (RSPS)	25
		Structural (RSST)	40
Postaeration	POST A	Mechanical Aerator (RSSA)	20
		Diffuser (RSPD)	30
		Swing Arm Diffuser (RSPH)	30
		Structural (RSST)	40
Primary Clarification			
Primary	PRIMAR	Mechanism (RSMS)	40
Two-Stage Lime	L PRIM	Structural (RSST)	40
Pumping	PUMPIN	Pump (RSPS)	25
		Structural (RSST)	40
Pure Oxygen	PURE O	Mechanical Aerator (RSSA)	20
		Oxygen Generation Unit (RSSP)	20
		Cryogenic Unit (RSCP)	20
		Pump (RSSP)	25
		Structural (RSST)	40
Rapid Infiltration Land Treatment	RAPID	Steel Pipe (RSSP)	20
		Butterfly Valve (RSBV)	20
		PVC Pipe (RSPP)	20
		Concrete Drainpipe (RSCP)	20
		Water Wells (RSMW)	20
		Pump (RSPS)	25

Unit Processes	Key Word	Cost Item	Replacement Schedule (years)
Rapid Infiltration Land Treatment (Continued)	RAPID	Fence (RSFN)	15
		Structural (RSST)	40
Raw Sewage Pumping	RAW SE	Pump (RSPS)	25
		Synchronous Motor (RSMS)	25
		Drive Module (RSVS)	25
		Structural (RSST)	40
Recarbonation	RECARB	Capital Cost (RSST)	40
First Stage Recarbonation	FIRST	Capital Cost (RSST)	40
Second Stage Recarbonation	SECOND	Capital Cost (RSST)	40
Rotating Biological Contactor	RBC	RBC Unit (RSES)	15
		Pump (RSES)	25
		Structural (RSST)	40
Screening	SCREEN	Capital Cost (RSST)	40
Secondary Clarification			
General	CLARIF	Mechanism (RSMS)	40
Activated Sludge	A SECO		
Denitrification	D SECO	Structural (RSST)	40
Nitrification	N SECO		
Oxidation Ditch	O SECO		
Pure Oxygen	P SECO		
Trickling Filter	T SECO		
Slow Infiltration Land Treatment	SLOW I	Pump (RSPS)	25
		Steel Pipe (RSSP)	20
		Butterfly Valve (RSSV)	20
		Impact Sprinkler (RSEN)	20
		Liner (RSLL)	15
		Fence (RSFN)	15
		Water Well (RSMW)	20
		Sprinkler System (RSPC)	20
		PVC Pipe (RSPP)	20
		Embankment Protection (RSBA)	40
		Structural (RSST)	40
Trickling Filter	TRICKL	Media (RSFM)	40
		Distributor Arm (RSAS)	40
		Pump (RSPS)	25
		Structural (RSST)	40
User-Specified Sludge	USER S	Capital Cost (RSST)	40
Vacuum Filtration	VACUUM	Vacuum Filter (RSSF)	25
		Structural (RSST)	40
Wet Oxidation	WET OX	Capital Cost (RSST)	40

b. Small system unit processes:

Unit Processes	Key Word	Cost Item	Replacement Schedule (years)
Activated Sludge	ACTIVA	Package Plant (RSSP)	20
		Structural (RSST)	40
Aerated Lagoon	AERAT	Mechanical Aerator (RSSA)	15
		Liner (RSLL)	15
		Structures (RSST)	40
Bar Screens	SCREEN	Bar Screen Unit (RSTB)	20
		Structural (RSST)	40
Clorination	CHLORI	Chlorinator (RSCL)	15
		Structural (RSST)	40
Coagulation	COAGUL	Upflow Clarifier (RSCL)	40
		Structural (RSST)	40
Sludge Drying Beds	DRYING	6-in. Pipe (RSCP)	20
		Structural (RSST)	40
Dummy	DUMMY	Capital Cost (RSST)	--
Equalization	EQUALI	Floating Aerator (RSSA)	15
		Liner (RSLL)	15
		Structural (RSST)	40
Filtration	FILTRA	Package Filter (RSSF)	20
		Structural (RSST)	40
Flotation	FLOTAT	Flotation Unit (RSSF)	30
		Structural (RSST)	40
Intermittent Sand Filter	INTERM	6-in. Pipe (RSCP)	20
		Steel Pipe (RSSP)	20
		Structural (RSST)	40
Lagoon	LAGOON	Steel Pipe (RSSP)	20
		Butterfly Valve (RSSV)	20
		Liner (RSLL)	15
		Structural (RSST)	40
Overland Flow Land Treatment	OVERLA	Pump (RSPS)	25
		Steel Pipe (RSSP)	20
		Butterfly Valve (RSSV)	20
		Sprinkler (RSCS)	20
		Liner (RSLL)	15
		Embankment Protection (RSBA)	40
		Fence (RSFN)	15
		Water Well (RSMW)	20
		Concrete Drainpipe (RSSC)	20
		Structural (RSST)	40
Oxidation Ditch	OXIDAT	Brush Aerator (RSDS)	15
		Pump (RSPS)	25
		Structural (RSST)	40

Unit Processes	Key Word	Cost Item	Replacement Schedule (years)
Postaeration	POST A	Mechanical Aerator (RSSA)	20
		Diffuser (RSPD)	30
		Swing Arm Diffuser (RSPH)	30
		Structural (RSST)	40
Primary Clarifier	PRIMAR	Mechanism (RSSM)	40
		Structural (RSST)	40
Pumping	PUMPIN	Pump (RSPS)	25
		Structural (RSST)	40
Rapid Infiltration Land Treatment	RAPID	Steel Pipe (RSSP)	20
		Butterfly Valve (RSBV)	20
		PVC Pipe (RSPP)	20
		Concrete Drainpipe (RSCP)	20
		Water Wells (RSMW)	20
		Pump (RSPS)	25
		Fence (RSFN)	15
		Structural (RSST)	40
Raw Sewage Pumping	RAW SE	Pump (RSPS)	25
		Structural (RSST)	40
Secondary Clarification			
Oxidation Ditch	O SECO	Mechanism (RSMS)	40
Trickling Filter	T SECO	Structural (RSST)	40
Septic Tank and Tile Field	SEPTIC	6-in. Pipe (RSCP)	20
		Structural (RSST)	40
Slow Infiltration Land Treatment	SLOW I	Pump (RSPS)	25
		Steel Pipe (RSSP)	20
		Butterfly Valve (RSSV)	20
		Impact Sprinkler (RSEN)	20
		Liner (RSLL)	15
		Fence (RSFN)	15
		Water Well (RSMW)	20
		Sprinkler System (RSPC)	20
		PVC Pipe (RSPP)	20
		Embankment Protection (RSBA)	40
		Structural (RSST)	40
Sludge Drying Lagoons	SLUDGE	Structural	40
Trickling Filter	TRICKL	Media (RSFM)	40
		Distributor Arm (RSAS)	40
		Pump (RSPS)	25
		Structural (RSST)	40
User-Specified Sludge	USER S	Capital Cost	--